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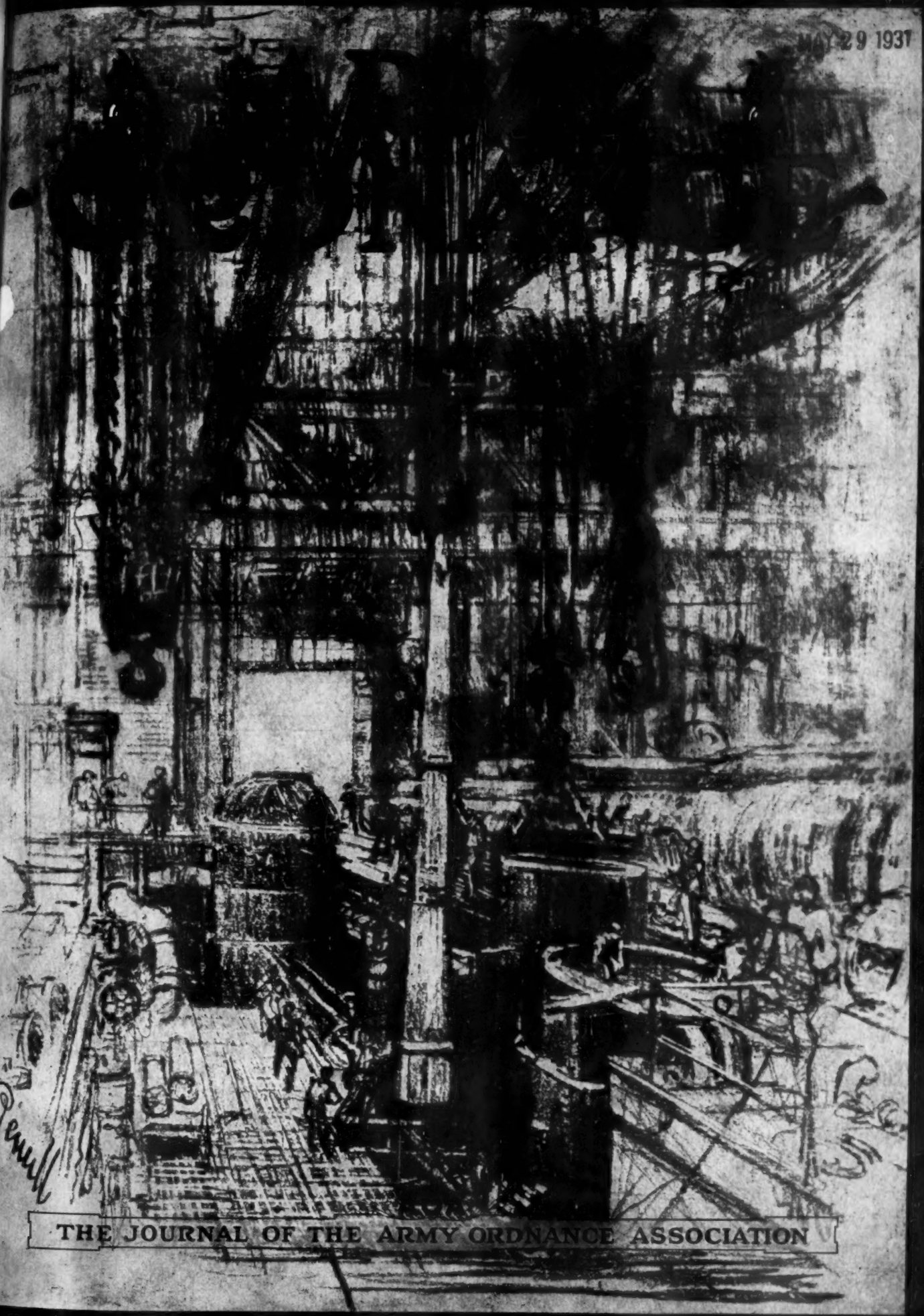

THE JOURNAL OF THE ARMY ORDNANCE ASSOCIATION

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ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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"The industrial war plan must conform to the living body of industry—to its customs, practices, organization and character. No human mind can grasp every detail. It can only be developed by years of labor and research. Occupying the space between the continuously changing body of industry and the intermittently changing war plan, it must slowly shape itself to each."

—Patrick J. Hurley, Secretary of War.

The Army Ordnance Association

THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guarantee of peace.

The Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

THE Army Ordnance Association believes that the solution of this problem, based on experience, lies in an active organization at all times coöperating with the Government. The principal objective of the Association is an active membership of American citizens, on whom the duty of design and production of munitions will fall in war, who will have an accurate and authentic knowledge of the complex requirements of ordnance. "Peace insurance" in this form is the foremost aim of the Army Ordnance Association.

The Association is purely patriotic; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration.

ARMY ORDNANCE, the journal of the Association, is published solely for the purpose of disseminating information on the progress of our munitions developments so that American industry may at all times know its responsibilities to the common defense.

The objectives of the Association as set forth in its Constitution are:

To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American scientists, inventors, engineers and manufacturers in civil life and the regular and reserve officers of the Ordnance Department.

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

To commemorate the services rendered by the industry of the nation and by the officers and civilian employees of the Ordnance Department in the wars in which the United States has been engaged.

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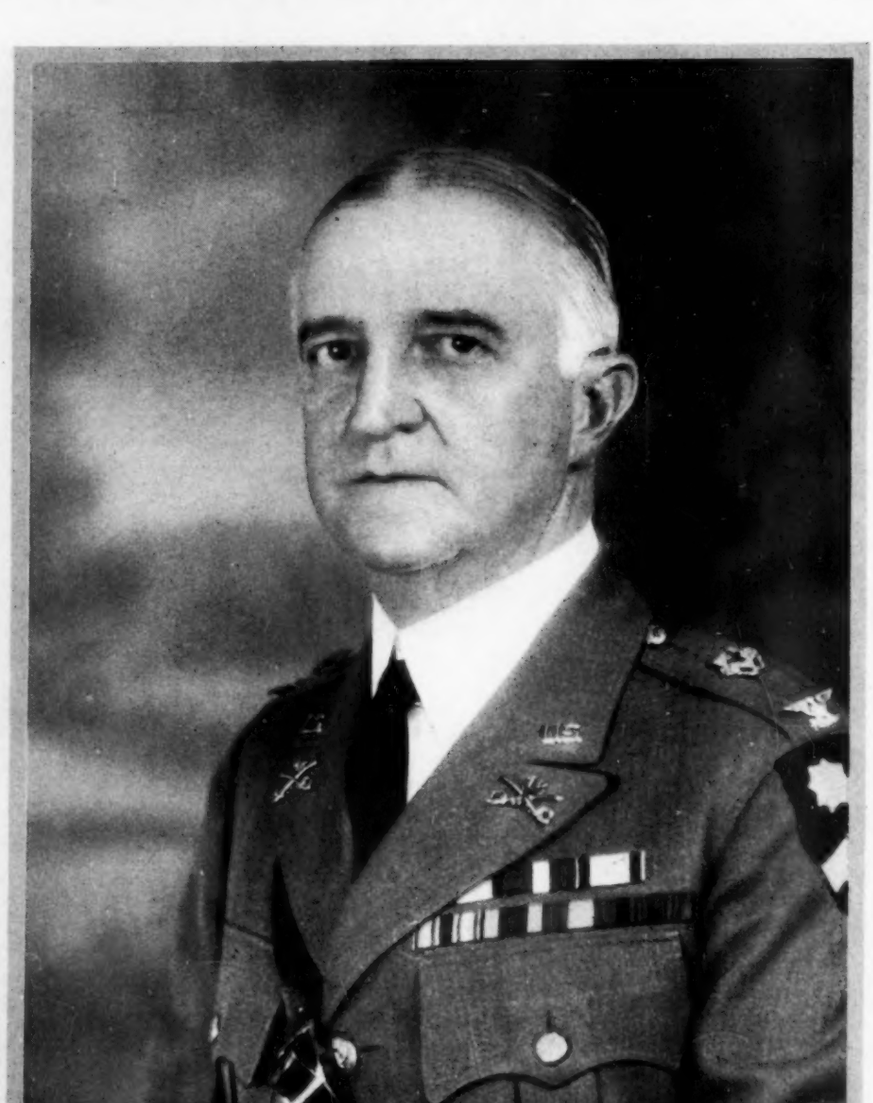


Col. Daniel VanVoorhis, Cavalry, U. S. Army

Head of the Mechanized Force, a New Tactical Unit of the Army
for the Determination of the Battle Applications of
Mechanical Developments

ARMY ORDNANCE

VOL. XI MAY-JUNE, 1931 No. 66

Munitions Problem of the United States

The Means by Which the Ordnance Department Seeks Its Solution

By Maj. Gen. Samuel Hof*

I AM undertaking in the limited space of a few pages in ARMY ORDNANCE to present a brief outline of the Ordnance part of the munitions problem of the United States. I know that readers of this Journal are interested from the standpoint of the engineer and industrialist in the arrangements which the Ordnance Department has made to provide the matériel essential to the fighting troops. The provision of fighting tools covers a wide field, both in a geographical sense and in a sense of the character of administrative work. We may readily subdivide the subject into definite parts as follows: (a) requirements; (b) stocks; (c) procurement, and (d) standards. These phases are given in the order in which they affect the munitions problem. They also appear on the outline organization chart of the Office of the Chief of Ordnance in Washington (see page 425) under the subdivisions responsible for each phase.

The primary information upon which Ordnance plans are based is received from the War Department General Staff in the form of war plans, mobilization plans, tables of basic allowances, wastage and consumption factors, etc. From these data it is possible to set up a series of requirements for the several types of arms and ammunition. The records showing what is expected from the Ordnance Department under these various situations I shall call, for convenience, the Book of Requirements. The responsibility for the completeness, the accuracy and the up-to-dateness of this book rests upon the General Office of the Ordnance Department.

From previous operations of the Ordnance Department over many years, there have been accumulated stocks of arms and ammunition which are stored in the Ordnance depots, arsenals, and other convenient storage facilities over the United States and its possessions, or are issued to components of the Army. A set of records is maintained in the Ordnance Office indicating the quantities, condition and location of these items. This record I shall call, for convenience, the Book of Stocks. The responsibility for the completeness, accuracy, and up-to-dateness of this book rests upon the Field Service of the Ordnance Department.

The difference between the stocks on hand and the requirements indicates the quantities of matériel required to be procured at the proper times for the armies which may be assembled for any plan of war. The records indicating the quantities to be procured I shall call, for convenience, the Book of Procurement. The responsibility for the completeness, accuracy, and up-to-dateness of this book rests upon the General Office of the Ordnance Department. The procurement of the items set forth in this book is the responsibility of the Manufacturing Service of the Ordnance Department.

Because of the constant demand for the improvement of the combat matériel to be issued to the armies, research and development are carried on under the supervision of the Ordnance Department, in close liaison with the using services, to produce more effective combat matériel for the use of the Army. Whenever a new standard is acceptable to the General Staff and the using services, it is "set up" for procurement. The list of standards declared satisfactory for procurement or for issue to the Army is assembled in the Book of Standards of the Ordnance Department. The responsibility for the completeness, accuracy, and up-to-dateness of this book rests upon the Technical Staff of the Ordnance Department.

The operations of the Ordnance Department in connection with the making and the use of these four books—requirements, stocks, procurement, and standards—will cover the general field of Ordnance munitions.

I WILL discuss first the set of records which we have called the Book of Requirements.

The Book of Requirements is made up from data transmitted to the Ordnance Department in the form of mobilization plans, war plans, etc., and these data are translated by the Ordnance Office into terms of Ordnance items. Knowing the organization of the field armies to be assembled, it is a comparatively simple matter, although a laborious one, to calculate the initial equipment of any phase of the mobilization plan.

These initial requirements do not constitute all the requirements of the Ordnance plan. There must be applied to these numbers various factors of distribution, maintenance, wastage, consumption and safety which serve to increase the amounts which are demanded of industry. When all these factors are applied we are able to set up the rates of requirements, month by month, for each item. Such matters are easily expressed in the form of curves so that the situation as to calculated requirements may be readily interpreted, by experts in reading curves, for any given moment.

Before I leave the subject of requirements, I want to dwell a moment on the principal factors which affect the book under consideration.

Mobilization Plans: The rate at which the manpower of the country is mobilized will greatly affect the quantities of ordnance for which production plans must be made as well as the rate at which this ordnance may be produced. Men are no sooner assembled into camp and organized into units

*Chief of Ordnance, U. S. Army.

of one of the arms or services than they demand the weapons of the fighting arms to which they are assigned. The supply of arms must follow closely upon the supply of men. Too rapid mobilization will make too high the curve of initial requirements to allow a proper response from industry. Every draft of men to camps removes some men from the factories who might well be employed on the production of weapons. Brave men and young men, no matter how essential in industry, will try to go to war. They cannot be held back if places are available in the ranks. We must be careful not to cripple industry by rapid mobilization before the mobilization is essential.

Operation Plans: The requirements, particularly those of ammunition, go up very rapidly with the number of troops sent into the theater of operations. It is not conceivable that unarmed or improperly armed troops should be offered for sacrifice. Their loss prejudices the morale of the succeeding troops. Common sense must be applied to the initiation of combat, and combat plans cannot be made without thorough knowledge of the rate of delivery of supply. These plans therefore must be made with the industry of the country. The Book of Requirements must be set up with the probabilities of supply constantly in mind.

Wastage Factors: Requirements must provide for replacement of items lost through ship and train wrecks, training breakages, service accidents, hostile fire, capture, and wear and tear. A divisional gun and carriage, for instance, is figured to last so many months in the theater of operations, as determined from experience of the World War. Other factors of wastage are calculated for other items of ordnance. If these factors can be reduced by building sturdier matériel, by better care in the hands of trained troops, by better protection through the better organization of troops and battles, or by any other means, as much as one or two per cent, a great saving is at once indicated at the factories and on all the transportation lines.

Consumption Factors: The number of rounds of ammunition required per gun per day in training and in the theater of operations is a factor of tremendous effect. Some 5,000 divisional guns at 20 rounds per day for 100 days require 10,000,000 rounds of ammunition. At 10 rounds per day the munitions program is cut in half, the transport is half, the gun wear is half, and more men are released from the service of supply. By greater accuracy of fire, through better fire-control instruments, more perfect powders and projectiles, better shooting guns and carriages, and, above all, more thorough training of personnel, we should be able to keep down this factor. By securing more effect at the target through better fuzes, more powerful explosives, better fragmentation of projectiles, better gases, better smokes and other effects, we may accomplish results with a smaller outlay. By a careful control of commanders in conserving ammunition for its full battle effectiveness, by a full knowledge of the probability factors of matériel, in knowing when the desired effect is accomplished, still less munitions effort may be demanded at home and still less transportation required of the service of supply.

Maintenance Factors: In addition to losses of whole items from one cause or another, damage occurs to mechanisms, due largely to their hard service, their delicacy, the low factor of safety required for mobility, and like reasons. For constant service, spare parts must be ready and are always included in the requirements. When units are on hand and no spare parts have been provided, it is usually necessary to disassemble some of the parts and use them for spares. Experience with each item determines the factor to be used for maintenance.

Overhead Factor: This is a distribution factor. It depends upon the echelon of stocks between the factory and the firing lines, and upon the number of stations to be stocked along the whole line of communications. The ideal condition would result, of course, if all supplies could be shipped by air express from the factory to the fight. But we all know that this is quite impossible. The component makers must stock their product until carload lots are accepted. The assembly shops must accumulate a balanced supply of components to keep the lines of workmen occupied. The packers and shippers, the railroad depots, the steamer wharves and rail junctions, the base depots and railheads all accumulate little reservoirs, like dams along a river, which serve to regulate the flow at the final stations. This factor must be taken into account in any provision system delaying the initial supply and holding unusable stocks at the end of the war. Staff plans must remember that there is such a thing as too many depots, too many frozen stocks, and plans should require as few as possible consistent with good distribution.

Factor of Safety: The ideal system would set no more requirements than would be actually needed for the battles to be fought. The old army system would require a demand for double the amount needed, knowing that we might get, after all the cuts along the line, about what was needed. The safe system lies somewhere between these two but, of course, should make the errors on the plus side. Common sense tells us there will be failures in every plan no matter how perfect the preliminary arrangements. What I want to emphasize is the fact that excessive requirements are apt to be set up unless we are careful. Unless the closest touch is kept with the progress of events, we may needlessly cripple industry and cause unnecessary hardships on the people at home.

When all the proper factors have been applied to the requirements, a complete book has been obtained. As a matter of hard fact, no such finished book is ever attainable, for the data are never fixed. Changes in plans, in factors and in the matériel itself occupy a considerable number of people in keeping the Book of Requirements in order for war purposes.

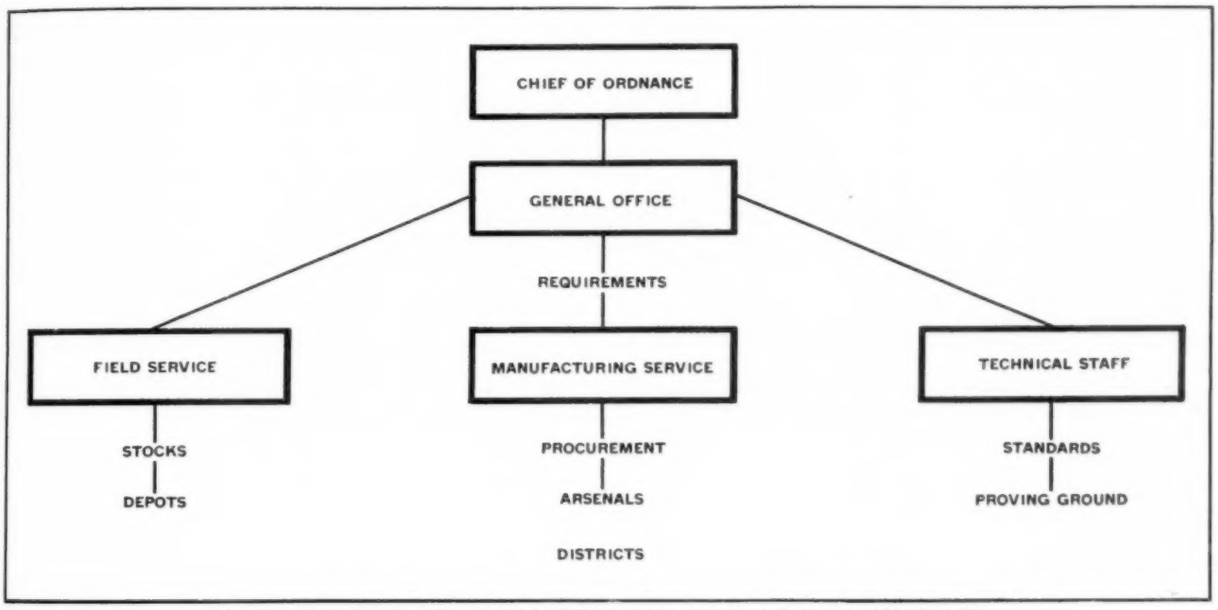
I WILL now discuss that set of records which I have called the Book of Stocks.

Records: By means of accounting machines, a periodical accurate review of all stocks in the several storage places is kept. Our records also indicate the quantities in the hands of troops, schools, and like places. For some years as Chief of the Field Service of the Ordnance Department, I was responsible for these stocks and their handling. I am confident of our book. An accurate knowledge of the quantities and conditions of stocks on hand is the first essential of munitions control.

Maintenance of Stocks: The effective maintenance of these stocks, as well as the effective maintenance of arms in the hands of troops, reduces wastage and reduces the quantities required from the factories. The surveillance of

powders, the renovation of deteriorating units, the protection of perishable stores from the elements and from contamination, oxidation, and other destroying effects prolongs the life of our reserve munitions and reduces the war problem.

We were fortunate enough after the World War to get the important Ordnance munitions left over from that conflict assembled into several depots, arsenals and military posts, and to provide some kind of housing for the more perishable items. The sorting, naming, marking, accounting for, and preserving these stores in place have consumed entirely the funds available to the Ordnance Department.



Outline Organization Chart of the Office of the Chief of Ordnance Showing the Functional Responsibilities of the Three Major Services.

Of the eighteen Ordnance depots, in the continental limits of the United States, ten are of war-time construction and the facilities are of a temporary character. Maintenance requirements for such facilities are abnormally high and funds appropriated are hardly sufficient to keep pace with deterioration. Gradual reconstruction or abandonment of these depots is inevitable. The provision of proper housing for the reserve munitions is an important phase of our munitions problem.

Deterioration: Even with the best housekeeping facilities which the country could provide, certain stocks will gradually pass out of the picture. Rapid manufacture of smokeless powder during the World War did not produce the long life of peace-time powders. All powders in our ammunition will have to be replaced within definite and fairly well-known periods, for there is no such thing as absolute dead storage. Complicated mechanisms, such as recuperators, recoil cylinders, pumps, and the like have to be disassembled to apply and renew preservative materials. Such stores require much labor and expense throughout their storage period as well as when reassembly for issue is demanded.

Improvement by Modification: To make our war types more efficient, changes are made in the matériel in service. These changes are sometimes essential to provide for using new types of fire control and ammunition. Because of shortage of funds it is not possible to modify all stocks in storage, and to some extent these stocks are falling behind the service tools. Such changes must be made before issue.

Obsolescence: The most serious effect of the years is the gradual obsolescence of all stocks. It would have been suicidal to have attempted to fight the World War with Civil War cannon, or with the 3.2-inch guns of 1886. It is remarkable that we did fight with a French model of 1897. There is always the question whether it is better to have much equipment of poor quality, or little equipment of excellent quality. It is a truism to say that to have the best equipment in adequate quantity is the ideal condition.

I WILL now take up the Book of Procurement. Our present mobilization plan, upon which procurement plans are based, calls for the assembly of a certain number of armies within a specified time. Hence there is a definite proportion of each of the items remaining to be procured for the *initial* equipment only of these armies. When the various factors are applied to these items of equipment and the whole requirement is set up, the stocks on hand are subtracted to make the Book of Procurement.

It is needless to say that we are likely to call to the colors a greater number of troops than that for which we are authorized to hold reserves. It is therefore essential that our procurement plans should provide for the equipment and supply of the maximum armies as soon as possible after they are mobilized, using our stocks and our production facilities to the greatest possible efficiency.

Ordnance Office: The Ordnance Office is organized and instructed to prepare for the full procurement of Ordnance munitions to meet as far as practicable the requirements of the mobilization plans which are set up for emergencies. The Book of Procurement is subdivided into classes of equipment as follows: artillery, automotive, fire control, small arms, aircraft armament, ammunition. Each class is assigned to a division of the office, and each division is subdivided into sections, so that especially trained men may assume control over the procurement of items with which their organizations and they themselves are familiar.

The Arsenals: The six Ordnance manufacturing arsenals are available to these units for the procurement of many noncommercial items, for the manufacture of which the arsenals are especially equipped.

They are essential to keep alive the art of producing special war weapons, to develop new designs, to prepare descriptions of manufacture of noncommercial designs, to perfect specifications and procurement data for our procurement agencies, and in war time to instruct commercial plants in methods of production of noncommercial items frequently quite foreign to their normal products. But, their total output is a very small percentage of the war requirements of our armies. It is essential that a large part of our commercial manufacturing facilities be immediately diverted upon the outbreak of war to the task of producing ordnance.

Procurement Districts: To accomplish this diversion of industry from its normal work to the new and abnormal tasks of war production, the country has been divided into fourteen procurement districts, each organized for war as a complete procurement unit. The personnel consists of a district chief, and an advisory board selected from the representative business men of the community, an executive selected from the regular officers of the Ordnance Department, and a large group of Ordnance reserve officers, selected from those available in the district, assigned to their war procurement tasks.

Surveys: With the advice of this organization, the manufacturing capacity of the district is surveyed by the district executive and our office is advised of the capabilities of such manufacturing plants in the district as are likely to be useful in Ordnance war production.

Allocations: With this information, the procurement divisions distribute the war procurement over the country to the best advantage for prompt and continuous production, in accordance with the Book of Procurement.

The executives, with the support and assistance of the district chiefs, then present to the selected plants the schedules of production of the various items of ordnance and wherever possible secure the acceptance of these schedules for war manufacture.

Descriptions of Manufacture: Once the schedules are accepted, the real work of arranging the prompt production of the Ordnance item begins, for it is not likely that the plant has seen such an item before, nor is familiar, with the character of work required of the finished product. To get a commercial plant into prompt production, complete drawings and specifications, complete bills of material, complete descriptions of methods of manufacture, and complete information as to allowed tolerances for final acceptance are required. When these are provided, the plant begins its study of the work and prepares a special plan for the production in its own factory with the facilities available or procurable. You will readily see that the completion of each one of these steps shortens the time when production may be expected, and brings back the point where production meets requirements.

Educational Orders: If we should be allowed to go one step further in peace time and place with manufacturers having accepted schedules of production a trial order for the material they are to produce in war time, we will insure that a complete knowledge of their capabilities coördinated with our acceptance limits of quality would be obtained. More months would be saved in obtaining our needs.

At present, when we procure from commercial firms, we must receive bids and must accept the lowest responsible bid, although the bidders may not be adequately equipped for war production or may not have accepted any war schedules. The educational order would permit us, with a slight increase in cost, to place orders with prospective war producers and to have these producers prepare their plants for their war tasks.

In 1914-15 our commercial plants received large war orders from the Allies for shell, steel, powder and other munitions. These were in fact educational orders for us, and prepared many plants promptly to take up our manufacture in 1917. These war facilities are now diverted to other work. Any up-to-date knowledge our plants may obtain must come from peace-time educational orders.

Coördination of Plans: You will see that only by the efficient operation of our procurement divisions with the arsenals and the districts can we obtain reliable peace-time estimates of war-time possibilities. If plans are not made at all or are insufficient in detail to make early production practicable, we run the danger of relying in time of war upon production which will not be attained. On the other hand, if peace-time planning is carried too far and encumbered with too many details, we run the danger of dulling the enthusiasm of those concerned and of failing to get adequate results. War procurement preparation is a long, tedious job that must be handled with sound judgment to get results.

Loading Plants: There is another phase of procurement which cannot be given to our industrial plants quite so easily as the machine work which I have so far stressed. This is the loading plant phase, the phase where all ammunition components are assembled into complete rounds and sent out ready for use.

In view of the fact that practically nothing similar to the operations at loading plants is conducted in civil life, that such plants cannot be located near thickly populated areas, and that the necessity exists for the strictest possible enforcement of regulations to prevent accidents, it is considered most advisable that the loading plants be operated by the Ordnance Department and that the management thereof be commissioned personnel.

Our plans call for the erection of a number of loading plants in different parts of the country, as many of them as possible being located on Government-owned land, in order that plans can be made and adapted to the site before war is declared. We have classified these plants into first-phase and second-phase plants. First-phase plants will be erected on Government-owned land, using existing buildings as far as possible.

This is not the only construction in which we are likely to be involved. Before the loading plant scheme can be complete, the powders, explosives and metal components must also be provided for. You will recall that an indicated shortage of smokeless powder for 1919 forced the Ordnance Department to build 15 powder manufacturing units—9 at Old Hickory near Nashville, 6 at Nitro, W. Va.—each with a capacity of 100,000 pounds of smokeless powder per day, a total output of 1,500,000 pounds per day. Behind these plants had to be plants for nitric and sulphuric acid and

following them had to be expanded plants for loading the powder output to make it useful to the firing lines. The time production curve for each phase and each factor had to be balanced to eliminate choke points and to insure that no wasted time or effort would appear between acquisition of the raw materials and final acceptance and delivery of the usable munitions.

I have pointed out to you three ways to move back monthly production toward the time of exhaustion of supply: by keeping a close estimate of requirements, by increasing the reserve stocks, and by careful preparations for augmenting war production.

I NOW come to the discussion of the Book of Standards, in which is written the kind of matériel the procurement divisions and districts must obtain.

In order that each new tool added to the list of combat matériel may be developed to its fullest possibilities, arrangements should be made for its thorough study, its improvement, manufacture, supply and maintenance.

The new Ordnance tools which have been added to the Ordnance war list since 1914 are tanks, armored cars, antiaircraft artillery, antiaircraft fire control, aircraft armament—both bombs and machine guns—chemical ammunition, tractors and prime movers for artillery, self-propelled artillery, new types of railway artillery, and new types of ballistic instruments. In addition to these new kinds of weapons, all the older types have been constantly and consistently studied, both by the services and by the Ordnance Department, under the plans set up by the Caliber Board, with a view to increasing the power, range, mobility, and convenience of our war tools. New types are being produced by the Ordnance Department and tested by each of the line branches and are passed upon by their respective boards. When a new weapon appears satisfactory, a fighting unit is equipped with it for an extended service test. The defects developed by this test are corrected and, upon satisfactory evidence from all parties concerned that the weapon is sufficiently superior to the old one to warrant its replacement, the new weapon is standardized for procurement. Of course, our research does not stop here and it may happen that this type may be again superseded in a few years.

Our engineers must be constantly studying the advances of science in chemistry, metallurgy and engineering to see what improvements may be made in our guns, mounts, fire-control instruments, trucks, tractors and automotive equipment. We must be continuously on the alert to see what commercial developments can readily be adapted to our use. New weapons must be fabricated and subjected to exhaustive test in time of peace. A continuous observation must be made of the weapons developed by foreign countries to see that our designs are at least as effective.

We cannot hope to man the forces with every contemplated change. The first cost would be prohibitive, aside from the cost of maintenance in storage and the cost of deterioration and obsolescence. But we must be prepared to provide our armies with the best fighting tools our ingenuity can devise as promptly as our great industrial capacity can produce them. A defeat on account of inferior tools would be unpardonable.

There is no doubt that the Book of Standards is the enemy of procurement planning for it is constantly changing. The Manufacturing Service has expended a part of its meager funds in setting up an elaborate description of manufacture for a standardized item, has succeeded in getting the districts to accept the production of this item, and has even had produced a general factory plan for its manufacture, only to be told that the item is being superseded by a new design. Fortunately, however, new designs grow from the old ones. They are not always radical departures. While the old studies and arrangements would have been essential, had war occurred, they are often recast to take up the new design.

It is the task of the General Staff jointly with the Line branches to decide upon the acceptance of new standards. We should remember that the fewer the designs, the less complicated the supply, the less often changes, the more complete the plans for procurement. Compromises must be made in the interest of adequate supply.

There is one other way to quicken the equalization of requirements and supply. That way is to limit the number of kinds of standard equipment. A German officer once stated that if all the energy, matériel, funds and personnel used by his nation on Zeppelins, long-range guns, gas, gas masks and other side issues, had been devoted to divisional artillery and its ammunition, there would have been many more victories to talk about in Germany.

I have now covered in a general way the field of our munitions work. I have intentionally omitted many phases of this work, all of which I know would be of interest.

It would not be proper for me to say that our Ordnance plans are in perfect order. I will say, however, that we have an earnest and hard-working crew constantly occupied with the revision and perfection of those plans. I have confidence in this, that, if an emergency should arise which may require an Ordnance effort comparable to that of 1917-18, we shall know where to apply our strength to secure the proper results, and shall be able without so much delay to put in motion the vast machinery which will put Ordnance munitions of the highest quality in the hands of our armies.

Defense Studies in Black and White

The Gracefully Delicate Billows of a Smoke Screen Laid Down by Navy Planes During Recent Tactical Exercises.

Clouds of Thick Black Smoke Pouring from the Funnels of the U. S. S. CINCINNATI During Recent Maneuvers.

The Tanks of the Mechanized Force in Their Carriers on the Road.

The Mechanized Force, U. S. Army

The Application of Commercial Developments to Tactical Uses

By Burton O. Lewis*

SO ACCUSTOMED have we become to the enjoyment, the innumerable benefits and luxuries of our modern civilization that the average individual seldom, if ever, stops to realize just how much he is indebted to the present mechanical age in which he is living for these many advantages. Mechanical appliances of every conceivable nature and degree of complexity for the elimination of human effort, are not only being perfected but are going far beyond anything previously known or considered feasible of attainment. Such is the trend of science and civilization today with which we are all more or less familiar and which we all enjoy in our everyday lives.

Such revolutionary changes in the methods of human existence cannot but be reflected in the Army. One of the most important developments of the last half century was the internal combustion engine, which gave to the military, during the World War the truck, the airplane, the tractor, and finally the tank. This means of propulsion was relatively new in 1914, so that its possibilities were far from full realization during the period of the World War. In fact, the enormous quantities of munitions—guns, ammunition, chemicals, explosives, etc.—which modern production methods made available all tended to bring about a condition of stalemate and stationary trench warfare. It was only towards the latter part of the World War that the mobilizing effect of the internal combustion engine began to make itself felt. Even so, these World War achievements in the gasoline-engine field were very substantial and served to indicate the military possibilities of motor equipment and to furnish a basis for future developments.

Regardless of the extent to which the United States Army was "sold" on motor equipment during the World War, motorization is an accomplished fact in the commercial and industrial life of this nation today. We should accept as a fact that motor equipment will be used to the maximum extent in any future emergency. The day of armies of first rate powers, limited in mobility to the marching ability of a soldier on foot, carrying his weapon and pack, is now passed and gone forever. Likewise, gone are the animal-drawn supply trains wherever motor vehicles can possibly be substituted.

Machine Gun and Firing Squad in Cross-Country Truck.

THE problem, therefore, resolves itself into one of determining how, in what form, and to what extent mechanical equipment can best be utilized by our

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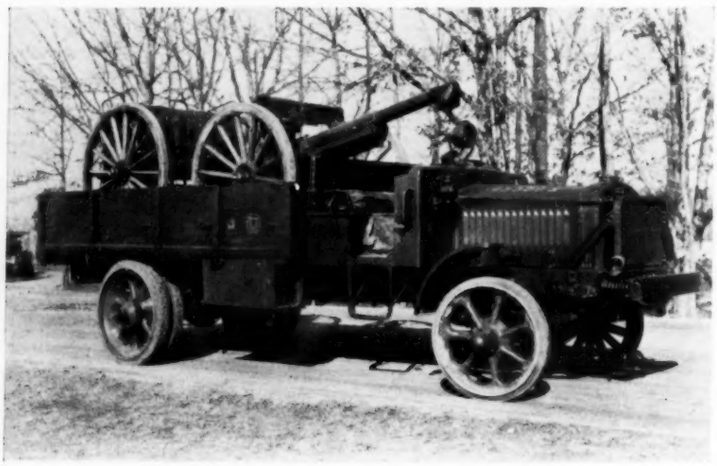
modern armies in their effort to conserve man power and to achieve success in a minimum of time. Since the World War, we have witnessed tremendous development in the truck, tractor, and airplane industries in view of their commercial application. The tank being a strictly military vehicle has been developed much more slowly. Considerable progress, however, has also been recorded in the tank field when the capabilities of the World War tanks are compared with those of recently developed pilot models. Light tanks used during the World War were able to maneuver across country at speeds of from three to four miles per hour. They could operate approximately ten miles on a filling of gas and generally required considerable overhauling at the end of that distance. We now have light tanks capable of operating twenty-five miles per hour on the road, eighteen miles per hour across country, sixty miles on one filling of gas and more than 2,000 miles before major overhaul becomes necessary. With other types of military automotive vehicles, such as self-propelled gun mounts, high-speed tractors, cross-country cargo carriers, and reconnaissance vehicles, considerable investigation and development have been carried on since the World War. The United States Army is now in the fortunate position of possessing much valuable knowledge of the capabilities and uses of automotive vehicles for military needs.



75-mm. Gun Loaded in Truck for Road Travel.

This detailed consideration of the possible uses of mechanical appliances and automotive vehicles in the military service has resulted in a differentiation between "motorization" and "mechanization," which are defined by the War Department substantially as follows. Motorization is the term applied to the substitution of motor-propelled vehicles for animal-drawn vehicles as used in all branches of the Army. It affects the strategical mobility of Army units by providing a method of rapid transportation of men, animals, equipment and supplies in motor vehicles over the roads. Mechanization implies application of mechanics and machinery directly to the fighting equipment of the soldier on the battle field. It affects the mobility and tactics of Army units by furnishing automotive, shock-resisting, fighting machines and automatic weapons to the soldier with which to carry on the actual battle. From the nature of its fighting equipment a mechanized unit would invariably include motorization, although a strictly motorized unit would not be mechanized.

As a culmination of the various post-war developments of automotive vehicles applicable to military use, the Chief of Ordnance, on November 5, 1927, in recommending to the Secretary of War the testing of a mechanized reinforced brigade stated, "This proposed mechanized reinforced brigade constitutes an organization having great strategic and especially tactical mobility, possessing tremendous shock and fire power when in the attack; and resistance when on the defense. By taking advantage of the remarkable achievements which have been made commercially in this country in the automotive industry, an Army organization of this character presents unusual opportunities and possibilities for increasing the effectiveness of our future armies. * * * It is urgently recommended that consideration be given to the placing under test of a mechanized reinforced brigade during the coming summer."

FOLLOWING War Department studies of the subject an experimental mechanized force was temporarily assembled at Fort George G. Meade, Maryland, during the summer of 1928 and maneuvers were conducted for a period of approximately two months. Much valuable information was accumulated from these maneuvers by the War Department and the decision was finally made to assemble at Fort Eustis, Virginia, in October, 1930, a mechanized force of a permanent nature. Some ideas on suitable equipment for a mechanized force had been crystallized as a result of the Fort Meade maneuvers, and some development followed thereon. On the whole, however, it was deemed advisable to assemble the mechanized force with such equipment as was then available, allowing the further development of necessary equipment to be based on experience gained from the continued maneuvering of a permanent mechanized force. This decision by the War Department is undoubtedly very sound, as the commercial industry of the United States

A Medium Armored Car (LaSalle).

is admirably qualified to produce any automotive equipment which may be required by the mechanized force. With regard to matériel, therefore, a most important duty devolves upon this mechanized force in making recommendations and preparing specifications for suitable equipment to meet its tactical requirements.

Col. Daniel VanVoorhis, a distinguished Cavalry officer of long and varied experience both in the field and in the War Department, was selected to organize and command the first mechanized force of the United States Army. The selection of such an able and eminently qualified officer indicates the keen interest of the Department in developing the full possibilities of this new arm.

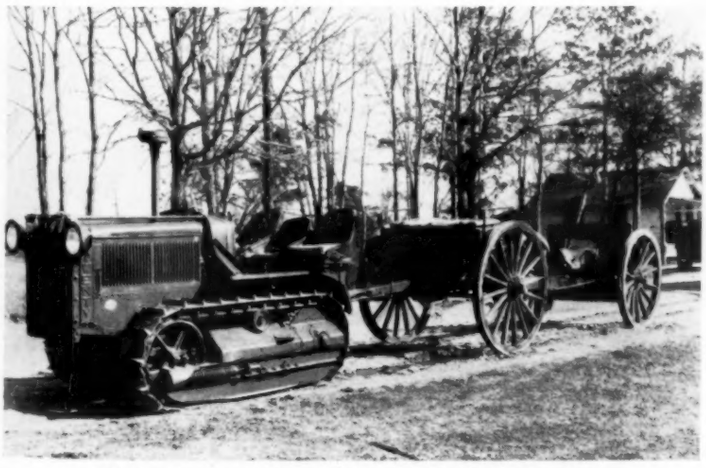
The personnel strength of the mechanized force at present consists of thirty-six officers and six hundred and forty-one enlisted men, drawn from the different arms and services of the Army. The organization is as follows:

Headquarters:
Force Commander and Executive Assistant.
General Staff Sections (S1, S2, S3, S4).
Technical Staff Officers (Technical Committee).

Combatant Organizations:
Armored Cars; Troop A 2nd Armored Car Squadron.
Artillery; Battery A 6th Field Artillery.
Tanks; Company A 1st Tank Regiment.
Machine Guns; Company H 34th Infantry.

Special Troops:
Headquarters Company.
Engineers; Company C 13th Engineers.
Chemical Warfare; Detachment Chemical Warfare Service.
Antiaircraft; Detachment 69th Coast Artillery.
Signal; Detachment Signal Corps.
Quartermaster; two Detachments of Quartermaster Corps for maintenance and supply.
Ordnance; 19th Ordnance Company.

The concentration of the mechanized force at Fort Eustis, Virginia, was completed in November, 1930. It is composed of old organizations having well-seasoned troops, trained in the care, operation and handling of their motor equipment.



Tractor-drawn Artillery With the Mechanized Force.

This organization is based on the theory that modern light tanks with their speed, armament and mechanical reliability are now capable of being employed on rather extended maneuvering. The light tank, therefore, becomes the principal offensive weapon and as such is aided and supported by the other components of the force. The force as a whole is capable of great strategical and tactical mobility, in addition to considerable offensive power under conditions of favorable terrain. The correct tactical employment of a mechanized force is the problem which must constantly be borne in mind, in order that the maximum value of such a highly mobile and powerful unit may be fully utilized.

4.2-inch Chemical Mortar on T-1 Tank Chassis.

THE two main problems which the mechanized force will have to solve as a result of its continued operations are the development of tactics and matériel. When the force was organized it was decided that these two problems could best be worked out simultaneously by the mechanized force itself. It is obvious that it is impossible to separate tactics from matériel as the two are, to a very great extent, mutually interdependent. The principles of war have not changed; neither is the mechanized force an answer to any new demand of modern warfare. Army commanders have always needed a force having great strategical and tactical mobility combined with considerable fire power, such as is possessed by the mechanized force. A modern mechanized force is simply the methods and means, provided by modern industry and the mechanical age in which we are living, of fulfilling this military need which has always existed. It furnishes the army commanders a much better means of accomplishing certain missions than has ever heretofore been available.

Part of the equipment of the mechanized force is new and modern, but the majority of it at present is of an experimental and makeshift nature. While unquestionably a long way from the equipment which should eventually be supplied to a mechanized force, it is equipment which can be worked with and serve as a basis for more ideal specifications and future developments. Meanwhile tactics are being studied and developed which will very greatly facilitate the preparation of specifications for the more suitable equipment.

The old problem naturally arises as to whether tactics should be developed to meet existing equipment or equipment should be built to suit ideal tactics. In any event

our solutions to the numerous problems must be practical ones. Some compromises will have to be made as is customary in the solution of all problems of mechanical design. Tactics, however, must never demand the impractical, nor the unreasonable; neither should they demand too frequent change if satisfactory mechanical progress is to be attained. On the other hand, definite specifications for equipment are necessary before development can be undertaken, and it is essential that these mechanical specifications describe equipment complying with the tactical demands.

It is thus seen that during its early existence the mechanized force will have to carry on a considerable amount of investigative and test work in the development of the equipment which it requires. In many respects the force is an ideal laboratory for the testing of equipment in

The Caliber .30 Antiaircraft Dual Machine Gun Mount on Truck (White).

which it is interested. It is unique in having representatives from so many different arms and services working together in a relatively small unit. Ample repair facilities are available within the force for the maintenance of vehicles under test, and it is axiomatic that the organization which is eventually to receive the equipment is best able to assist in its development.

Although the many varieties of vehicles which now comprise the equipment of the mechanized force may appear most confusing to a casual visitor, it is believed this condition is inevitable at the present time. We are going through a preliminary stage which cannot be avoided. The entire idea of mechanization in the Army is so new that it is impossible for any one now to state in terms of mechanical specifications the type of equipment with which a mechanized force should eventually be equipped.

During the past few years considerable attention has also been given to the subject of mechanization in certain foreign countries. A mechanized force is a powerful agency of national defense and should be based upon the particular conditions of the country to which it pertains. Such national features as terrain, water courses, mountain ranges, climate and, especially, the matter of distances, all have a very important bearing on the characteristics of the equipment of a mechanized force. The force from its nature is very sensitive to such conditions and it is quite reasonable to suppose that mechanized equipment may differ largely in different countries. The wide-spread areas and long coast lines of the continental United States appear to be most favorable for the operation and maneuver of mechanized forces.

WITH the foregoing as a background it is believed that a detailed consideration of some of the equipment problems of our mechanized force would be of interest. A discussion of this equipment will also serve to visualize for the reader the functioning of a mechanized force in so far as equipment influences methods of operation.

Armored Cars: The armored cars of the mechanized force carry on distant reconnaissance, function as covering forces, and in conjunction with other troops act with advance and rear guards, and on outpost duties. For the more distant operations, light, high-speed armored cars of the wheel type are employed. Such cars carry light armor and caliber .30 machine guns. Chevrolet, Whippet, and Plymouth touring car chasses were utilized in building these light armored cars. A medium type of armored car is built on the LaSalle touring car chassis. While somewhat heavier than the light armored cars, it has considerable speed and a certain amount of cross-country mobility. A still heavier type of armored car is represented by the special four-wheel-drive Franklin engined cars built at the Holabird Quartermaster Depot. This car weighs approximately 7,000 lbs., has considerable cross-country mobility and carries a caliber .50 machine gun. The light cars are capable of speeds of 50 miles per hour on good roads and the heavier cars somewhat more. The question as to whether or not track-laying or combined wheel-and-track-laying types of armored cars are necessary in the mechanized force is still an open one. Whether or not armored cars with the mechanized force should be equipped with heavier armament than the caliber .50 machine gun still remains to be determined.

Field Artillery: The field artillery with the mechanized force has two principal missions at the present time—accompanying artillery for the close support of the tanks, and supporting artillery for the force as a whole. To assist the artillery with the mechanized force in working out its two missions, both self-propelled and tractor-drawn portée artillery equipment have been supplied. The self-propelled artillery matériel consists of two 75-mm. gun, motor carriages Mk. VII and one 75-mm. pack howitzer mounted on an Ordnance track development chassis. An experimental wire reel mounted on a T1E1 tank chassis and an ammunition carrying body mounted on another T1E1 chassis have been furnished for experimental use in laying wire and supplying ammunition during cross-country operations.

The close support of fast light tanks in action by means of accompanying 75-mm. guns on self-propelled mounts presents a most interesting study for the artilleryman. The fast tanks of a mechanized force are certain to be opposed by cleverly hidden antitank guns as well as machine gun nests. To facilitate the advance of the tanks, these antitank guns should be brought under heavy fire as soon as possible after they have disclosed their positions. Communication to the rear-supporting batteries (beyond observation range) asking for their fire means loss of valuable time, even if it were possible to describe the accurate locations of the antitank guns. Direct fire at short ranges by the accompanying artillery appears to be necessary as it is not practical to give light tanks sufficiently heavy armament to combat antitank guns which would undoubtedly be of 75-mm. caliber.

For the supporting artillery work the battery has four French 75-mm. guns drawn by Caterpillar 20 tractors and

portéed on class B Liberty trucks. For purposes of comparison this battery is also supplied with two pneumatic-tired, two-wheel trailers, designed to carry 75-mm. guns and to be towed behind fast moving trucks. This method of rapid transportation of 75-mm. guns leaves the truck body free for carrying ammunition and personnel. Towing a two-wheel trailer behind the truck at high speeds on the roads, is, however, not entirely satisfactory.

Tanks: The tank company is probably confronted with the most numerous and difficult problems in view of the fact that the fast light tank is generally conceded to be the "back bone" of the mechanized force. This company is at present equipped with three types of light tanks; the 6-ton, Model 1917, used during the World War; the 6-ton, Model 1917-A1, which is the World War type modernized by the installation of a Franklin air-cooled engine giving the tank a maximum speed of eight miles per hour; and the T1E1,-2, and-3 tanks (completed by the Ordnance Department during the past three years), which have a cross-country speed of approximately fifteen miles per hour. These tanks all weigh from about seven and one-half to eight and one-half tons.

Armor and armament in a tank is had at the expense of speed and mobility. What are the minimum requirements of armor and armament that a light tank of a mechanized force should have in order that speed and mobility may be favored to the maximum? To assist in solving the armament problem, the tank company has caliber .30 machine guns, caliber .50 machine guns, 37-mm. low power guns and 37-mm. high power single shot, and semiautomatic guns. Likewise, the variety of speeds in the tanks at present with the company can be used as a basis for determining what the desirable cross-country speed should be.

All the tanks at present with the mechanized force are carried in trucks for road traveling. These are six wheel, solid tire, trucks especially built for this purpose by the Quartermaster Corps, at the Holabird Quartermaster Depot, Maryland. This method of travel means loss of time when the tanks are detrucked for combat. Of even greater tactical disadvantage are the trucks themselves from which the tanks have been removed. These strictly road vehicles would be extremely vulnerable in time of war, and would require a strong guarding force. In addition the tanks must necessarily return to their carriers for further distant transport. This method of transporting tanks on the road practically doubles the number of vehicles in a tank organization.

It is quite natural, therefore, that the mechanized force is watching with a great deal of interest the progress of the development of the combined wheel-and-tracklaying tank by its inventor, Mr. Walter Christie. A satisfactory wheel-and-tracklaying tank would meet all requirements for strategic speeds on the roads and, what is even most desirable, would eliminate the portée trucks in a mechanized force.

Machine Guns: The machine gun company of the mechanized force was drawn from the 34th Infantry Regiment, which had been motorized for the past two years. The company is organized into three platoons, each platoon having three machine guns. Each machine gun squad together with its gun, ammunition and personal equipment is transported in a six-wheel, cross-country, Chevrolet truck of ¾-ton capacity. Five additional trucks of the same type carry the spare guns, baggage and other supplies of the company. Three Chevrolet touring cars are provided for the company headquarters and reconnaissance detail, completing the equipment of the company.

Possessing great mobility, both on the roads and across country, this machine gun company is a very powerful adjunct to the mechanized force. It is capable of moving forward at high speed to seize important positions or to assist in the consolidation of ground taken as the result of tank offensives. The caliber .30 Browning machine guns are normally carried as far forward in their trucks as is considered practicable, then detrucked and moved to their firing position on wheeled machine gun mounts (Mathews type) with which they are equipped.

At the present time it is not contemplated firing these machine guns from their traveling position in the trucks.

An Indispensible Adjunct of a Mechanized Force—The Rescue Truck (Diamond T).

Whether such a requirement will be developed remains to be determined by further tactical operations of the mechanized force.

Engineers: To provide the field engineering necessary to facilitate the road and cross-country maneuvering of the mechanized force a company of engineers has been included in the organization of the force. It is anticipated that a mechanized force in action will often move on a rather broad front utilizing many secondary roads and trails. The prompt and effective conditioning of roads and bridges, to expedite movements, plays a vital part in the successful operations of a mechanized force.

Chemical Warfare: It is certain that the Chemical Warfare Service will be well represented in any mechanized force in view of the screening effect of smoke in assisting tank attacks. At present the detachment is armed with a 4.2-inch chemical mortar mounted on a light tank chassis (T1) for cross-country maneuvering. The range of this mortar is from about 600 to 2,400 yards.

Antiaircraft: A detachment from the 69th Coast Artillery Regiment provides the antiaircraft defense of the mechanized force. At present this detachment is equipped with caliber .50 antiaircraft machine gun mounts, installed on White trucks. Two of these are single gun mounts and the third is a dual gun mount.

It is accepted without question that a mechanized force will be subjected to attack from the air on the march, when halted and especially in camp. Our vulnerability from the air will dictate not only considerable night marching, but also going into and getting out of camp under

the cover of darkness. Our present machine gun antiaircraft equipment presupposes that we expect to be harassed by attack aviation only. Whether larger caliber antiaircraft equipment should be included in a mechanized force to ward off bombing planes is a question still open for discussion. Will a mechanized force spread out as it naturally would be, present a sufficiently attractive target to the bombing plane? We do not yet know.

Signal Corps: A detachment of the Signal Corps forms a component part of the mechanized force and furnishes the communications system. Control and coördination at all times of a widely separated, highly mobile force of considerable size, is a most difficult problem and one upon which the successful operations of a force are to a large extent dependent. Work on this problem is only beginning in the force and will undoubtedly exhaust every possible means of communication, such as voice, signal, light, radio, wire, runner, motorcycles, etc., before the eventually successful solution is achieved.

Quartermaster Corps: Two detachments of the Quartermaster Corps, one for supply and one for maintenance, are included in the organization of the mechanized force. Their duties consist of furnishing the Quartermaster supplies and providing maintenance for the Quartermaster vehicles of the force, which in general are of a commercial or near commercial type.

Ordnance: The 19th Ordnance Company conducts the Ordnance repair, maintenance, and supply functions of the mechanized force. The Ordnance equipment of the force includes guns, automatic weapons, fire control, and such special combat vehicles as armored cars, tanks, self-propelled artillery, antiaircraft truck mounts, special repair vehicles, etc. The company consists of two officers and approximately seventy selected enlisted men, specially trained in the maintenance and repair of Ordnance material. The equipment of the company includes a light machine shop truck; a generator truck, providing power for battery charging, electric arc welding, and night lighting; a wrecking truck with overhead trolley; light and medium cross-country repair trucks for the prompt maintenance of the vehicles of the force in their cross-country operations; and the necessary cargo trucks for transporting office records, baggage, and live spare parts (totaling about 8,000 items at present).

IT IS thus seen that the mechanized force assembled at Fort Eustis represents a large experimental undertaking on the part of the United States War Department. Consisting of nearly 200 vehicles at the present time it moves through ordinary traffic at eighteen miles per hour, extending along a single road (with proper intervals for such speed) for about eight miles. The Army is enthusiastically behind this project which promises to give future armies exceedingly mobile mechanized units of great striking power, capable of rendering inestimable service when favorable opportunities present themselves.

The most efficient mechanized force, however, cannot be developed by the Army alone. The coöperative assistance of American Industry is an essential factor in making it a success. Many problems of the mechanized force undoubtedly will be presented for the consideration of the Ordnance Advisory Committee of the Society of Automotive Engineers, and otherwise taken up with engineering societies and individual manufacturers. In any case the Army's object will be to enlist the whole-hearted coöperation and support of industry in making the mechanized force a real mechanical success—both tactically and technically.

A Part of the Mechanized Force Crossing the James River Bridge, Virginia

Possibilities of the Tank

Part I: Tanks in the World War

By Fred. H. Wagner*

IN the autumn of 1928 I went abroad in the person of a perfect tank enthusiast and at that time was prepared to sing the same character of song as was sung by Colonel Mettler in the July-August, 1929, number of ARMY ORDNANCE. But I came home with my enthusiasm considerably dampened. In the summer of 1928 I spent two weeks with the Mechanized Force at Fort Meade, Maryland, and from the conversation surrounding me there I was led to believe that the tank was the answer to a multitude of questions, and with this fond belief I encountered my friends in Europe only, alas, to have my convictions considerably shattered.

I am not speaking of motorization, but of tanks and tanks only, which may be analyzed as the backbone of any mechanized force. I may be "barking up the wrong tree," but you will at least pardon my zeal, since I was probably led into this discussion by a remark made to my very good friend, General Tschappat, a short time ago. At least I feel sure that the invitation to prepare this series of articles was due to my request of the General that I be permitted to spend some time with the tanks during the coming summer.

As I understand the subject, a mechanized force would be employed about as follows: Distant reconnaissance of the enemy would be first made with airplanes, after which ground reconnaissance would follow by means of fast moving armored cars. The enemy being thus located, or his intentions ascertained, a possible attack by the mechanized force would follow. This attack would be launched by a first wave of light tanks, rapidly moving forward under possibly a smoke screen and closely supported by self-propelled artillery. This would be followed by the advance of heavy tanks in waves followed by vehicles manned by machine gunners whose duty would be the mopping-up and consolidation of the ground gained. This would mean a running over of the enemy's position, after which advantage would be taken of the "break-through" by the arrival of infantry which, besides the rifle, would be equipped with preponderant machine gun and automatic rifle power, their duty being to hold the ground until the arrival of the regular divisional infantry.

With this idea in view, the British, at the time of which I speak, organized a mechanized or "armored" force which organization, however, was not satisfactory and was being revised, but the new set-up was not made known to me before I left England.

The picture of operation as previously given is a very pretty one, providing it works to the same advantage during war, or when the enemy has something to say about it, as it does in peace maneuvers, but as a final analysis the entire action is based on the results obtained by the tanks.

It is not my intention to describe the tanks built, building, or being designed in Europe, since Maj. C. C. Benson has given a very comprehensive description of these in the July-August and November-December, 1929, numbers of ARMY ORDNANCE, but I will confine my remarks to the questionable utility of the weapon, or questionable in that I do not deem it possible for the tank to give the results so confidently predicted by many enthusiasts.

In doing this I would call to your attention the following statistical information, or information which I presume you already possess, yet to me it is so vital in forming conclusions that I cannot refrain from repeating it.

ON November 20, 1917, at Cambrai, four hundred and seventy-six British tanks, without any preliminary bombardment, in a surprise attack rolled over the German Armies almost at will. This was the first actual meeting in the field of war, consequently it was something which had not been prepared for and, due to the surprise attack, led to a very successful issue, hence the tank was immediately hailed the panacea for the misfortunes of battle.

On November 21, however, or just twenty-four hours later, the consternation which covered the Germans on the day before seems to have evaporated into thin air, since at Fontaine-Notre-Dame twenty-three British tanks entered this village and encountered severe resistance. The demoralized Germans of the day before no longer took to their heels nor stood petrified only to be shot down, coupled with no surprise, but they concentrated in the upper floors of the houses and rained grenades on the tanks. Their mission was a failure, and they were compelled to withdraw under cover of darkness.

On November 30, 1917, or ten days after the tanks had met with such phenomenal success in a surprise attack, the Germans in turn, and without any tanks at their disposal, surprise-attacked the British at Cambrai and were successful in driving them out of their hard-earned positions, and which had been gained principally through the surprise occasioned by the tanks, a further proof that the heralded demoralization had evaporated. For countering this attack, the British, now on the defensive, had only seventy-three of their original four hundred and seventy-six tanks to oppose to the German tankless advance, and as soon as these seventy-three were confronted by direct gunfire they were compelled to withdraw from the fight.

On March 21, 1918, at Amiens, the British were in a strong position and had received warning of an impending attack. They were supported by three hundred and twenty Mark IV and fifty Medium A (Whippet) tanks. In spite of no tanks in the German Army while being confronted by the above array of this new weapon, the British were driven back almost to the gates of Amiens, losing guns and stores as well as some ninety thousand unwounded men. This does not lead to the belief that the Germans still feared the tanks, or that demoralization had been induced in them by the knowledge that the British had some three hundred and seventy tanks in support.

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The Second Battle of the Somme started six days later, or on March 27, 1918. There all but three of the Fifth Battalion tanks had to be destroyed by the British themselves on account of lack of fuel, and the three remaining ones were lost on the next day.

On July 18, 1918, Foch's X and XI Armies struck the Germans at Chateau Thierry and in the vicinity of Rheims. The Xth French Army was covered by three hundred and twenty-four light and heavy tanks, two hundred and twenty-five of which succeeded in getting into the action and they sustained one hundred and two, or almost fifty per cent, casualties, the German artillery alone accounting for sixty-two of these.

On the next day, July 19, the Third Heavy Tank Battalion lost all but two tanks, one of the latter reaching its objective. Of a total of one hundred and five tanks fifty were hit by direct shell fire and during the next few days thirty-two tanks were engaged in local attacks; seventeen of these were hit with a personnel loss of fifty-two per cent.

On July 21 we find one hundred tanks engaged, of which thirty-six were hit.

On July 23 eighty-two tanks were engaged, of which forty-eight were lost.

All of this happened during one of the greatest surprise attacks of the war, or where conditions might be considered ideal for tank work. Here the new Renault tank, which possessed greater speed and was less conspicuous, thus presenting a lesser target than the older ones, obtained its first major service. But the tanks were all but totally put out of action, and Ludendorff informs us that fire from the tanks was insignificant, while Hindenburg advises that the feeling of helplessness in the face of tanks had been greatly overcome. But artillery did the job!

On August 8, 1918, the Allies launched a surprise attack at Amiens. The British Corps had four hundred and twenty tanks, of which four hundred and fifteen got into action and one hundred of these were destroyed. That evening the remaining tank crews were so completely exhausted that it became necessary to organize composite companies for the next day's battle, and all this occurred under ideal tank conditions. The total tank loss amounted to twenty-five per cent.

On August 9, in the main attack, thirty-nine out of one hundred and forty-five tanks were hit by artillery, and on the same day in a minor engagement at Chipilly five out of sixteen were destroyed.

On August 10, thirty out of sixty-seven tanks received direct hits, and at Roye-Hattencourt-Hallu twenty-three out of forty-three were lost.

Summarizing this battle, we have four hundred and fifteen tanks going into action on the first day; on the second day this armada was reduced to one hundred and forty-five, a loss of sixty-five per cent, and on the third day this number was again reduced to sixty-seven, or a further loss of fifty-four per cent. General Fuller, who is an enthusiastic tank exponent, says: "A total of six hundred and eighty-eight tanks had been in action on August 8, 9, 10 and 11; four hundred and eighty machines had been handed over to salvage; very few of the remaining machines were actually fit for a lengthy action and all required a thorough overhaul."

Unfortunately for the Germans but fortunately for the Allies, the former failed to equip their infantry groups with a number of large-caliber automatic rifles directly after the tank appeared. Had they done so the tank losses would have been far greater than those cited above.

FROM Livesay I quote, "Without question the tanks played a great and formidable part in this battle * * * but that they were not vital to success was proved by the Canadian Corps later on, when its supply of tanks, at first scanty, rapidly was reduced to the vanishing point. * * * Early tanks failed or achieved but a moiety of success because they were too slow and too vulnerable. * * * In the Amiens show the tanks were massed and the wastage was so great that replacements on the same scale were difficult, especially as the widening of the battle line made an effective tank concentration more and more out of the question. In the Arras offensive very few tanks were in our (Canadian) line, and in the battle of Cambrai, because of the impassable nature of canals and rivers encountered, they were almost entirely absent. Very few, in fact, were left at all in the closing stages of the great offensive, and a localized concentration to overcome machine-gun resistance became impossible. Had it been otherwise our casualties would have been lighter."

Livesay is confident that tanks are ideal for destroying machine gun nests, but even here they must act in close concert with the other arms, and he continues "Above all they must have wider range of vision and be in direct communication not only with their own units but with other arms, especially infantry." He finally says, "In the last analysis it was the man with the machine gun, the man with the rifle, and the man with the bomb and bayonet that won our battles."

General Monash is another who feels that the tank can be looked upon only as a mechanical aid to an infantry advance, and that the tank can never replace the latter. Marshal Haig came to the same conclusion.

I will not elaborate here on tank design, since a great deal has been said and published on this subject, but a few remarks are in order. Who can imagine a tank constructed to withstand the fire of guns? Unless the tank can make a surprise attack it would be impossible to even think of success.

THE British tank enthusiasts all refer to the first Battle of Cambrai as convincing evidence of tank superiority and call attention to the great tactical value of the present day high-speed tank. You may increase the speed of the tank to the uttermost limit, but the shell from a gun is still swifter. Increase the tank's armor and she will be pitted against heavier guns. But it must be remembered that the tank is limited as far as weight is concerned, and increased weight does not mean only an addition to the motive power with its concomitants of fuel, oil, etc., in order to maintain the desired speed, but it will also cause the tank to be subject to tactical limitations, especially on marshy ground, or where the bearing power of the soil will not permit of its passage.

In other words, high speed means loss in armor or increase in engine power. The former may be well deemed fatal. If the armor is applied in such weight as to resist the caliber of guns which it might ordinarily meet in attacking

strong points, then the tank becomes larger and more conspicuous and is thus made a better target for artillery fire. In Europe the desire for speed since the war has, with the exception of the French 130-ton tank, unfortunately led to a sacrifice in armor. Speed, however, will naturally be a matter of terrain, and it is unfortunate that we cannot always select a suitable terrain for tank action, or one where the limitations of the tank will permit it to function as we may desire or intend.

During the war the tank was far too conspicuous for trench warfare, and due to this feature it often fell prey to artillery fire. For open warfare they were too slow, hence the present desire for speed, consequently their only success must be credited to surprise. But, on the other hand, even this element of surprise would have been of little value had it not been supplemented and supported by excellent team work, or by the constant pressure of the other arms, hence in my humbile opinion, as well as in that of others probably more capable of forming such opinion, with the exception of Cambrai, where the initial success was reversed in a few days, the tank may be considered to have been somewhat of a failure. These are probably harsh words, and they may not meet with the approval of tank advocates, but from the losses cited above, or losses which would have required extraordinary efforts above what had been previously accomplished, this opinion is gaining strength in many quarters in Europe.

Surprise attacks by tanks, in my opinion, are greatly a matter of the past provided the object lessons taught by the recent war are not pigeon-holed and forgotten, and it does not require much imagination to perceive that every future army commander will be on the alert for such surprises.

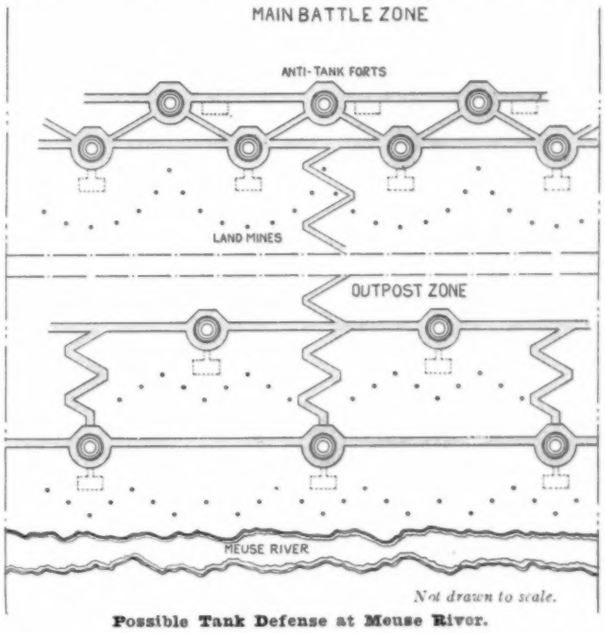
Should, for example, the army be advancing, it is reasonable to believe that both land and air scouts will be well to the front, and the commander will certainly be subject to a lack of reasoning power if he fails to have sufficient mobile antitank guns in positions where he can concentrate a resisting fire.

On the other hand, should he be on the defensive, the commander will certainly take pains strategically to locate strong points or antitank forts along his front. Commonsense will teach him to take advantage of all natural obstacles, and his strong points will be guarded by land mines of the mushroom variety which can be touched off from the strong point as well as by contact.

The tanks may employ a smoke screen to conceal their advance, but smoke is at the same time a detriment to the tank, since the guiding spirit of the tank cannot see just what it may encounter, and the defending army's artillery will certainly search such a smoke screen.

A tank advancing against a strong point will be the target for more than one gun, and these guns will be so located as to cover a much wider field of fire than is possible from the tank. You may attempt to answer this by sending out the tanks in waves or fleets which will cover a considerable sector of the front, thus dividing the fire from the defenders among several targets. The rejoinder to this is the actual casualties which occurred in tank fleets during the war and after the Germans had overcome their original fear of them. Had the Germans adopted their late efforts, or efforts made effective towards the close of the war, at an earlier date, the results so far as the tanks are concerned would have been even more fatal. These efforts consisted in assigning several guns to the outpost line of each divisional sector for tank defense only, and they were so disposed that they could quickly take such position as would permit of engaging the advancing tanks by direct fire, and this at a range of seven hundred and fifty to one thousand yards. What tank can resist a 75-mm. gun at this range?

LET us imagine a defensive sector arranged about as follows: The outposts will consist of strong points, or "pill boxes" as they were recently termed. The main battle zone will be located considerably in the rear of these outposts and will consist of a zone of strong points, inconspicuous because probably dug deep into the ground, and armed with guns of comparatively large caliber in such



Possible Tank Defense at Meuse River.

fashion that the points can support each other by means of flanking fire. Let us not assume that the outposts have actually been put out of action by a surprise attack. Will there then be an opportunity of pulling off a surprise attack on the main battle zone? Certainly not, for the outposts will surely have warned the rear of the impending attack. What else is then left to the attacker but to search for and locate each and every strong point in the zone and attempt to smother it with artillery fire. This sounds rather better than reality would impose; you might cover the zone with a barrage and drive the men into deep dugouts, but unless the barrel of a gun received a direct hit, or the whole crew is killed, the survivors would return quickly to their guns after the barrage had been lifted and would then have the tank at a distinct disadvantage through point blank fire.

The establishment of such a defensive battle zone is not a chimera, as witness the last proposed phase of German tank defense measures. This was to consist of a number of antitank forts each armed with four field guns, two minenwerfer having a flat trajectory, four antitank guns and two machine guns. The proposed plan called for locating these forts about three thousand yards behind the guns at the outposts and close to the main defensive line. This idea came rather late, and was employed only once or twice, but never

found action. Such forts with their equipment can be built much more quickly than can a tank, and one such fort could create sufficient havoc in a fleet of tanks as to make their replacement rather difficult.

You may say why not rush the main battle zone, but I cannot imagine anything more suicidal than such an attempt, for the attacking tanks would find themselves in a very inferno of shells, a deadening cross-fire at a range where missing the target would be exceptional, while the tank would be seeking a target for its fire.

The only other alternative would be an attempt to obliterate the battle zone strong points by an overwhelming artillery fire. But here again the defending artillery will have something to say and unless the attackers possess a preponderance of artillery the result will not be the expected one. If, however, the bombardment is a success then why the tank at all?

It must also be remembered here that the defense has had the opportunity to provide supplies in greater abundance than would be possible for the attacker, and these additional supplies and ammunition might be the measure of success or failure. Were not the Allies in just such a predicament at the time of the Armistice?

HAD the Germans contracted their front and established such a battle zone as described above—and which would not have been too difficult of accomplishment—with the determination to fight on, would the Allies have been able to continue their advance? I quote from Maurice, "Everywhere I was told that the Allied Armies, which were on or were marching towards the Meuse, had on November 11th reached or very nearly reached the farthest limit at which for the time being they could be kept regularly supplied, the plain fact being that on or very soon after November 11th it would, had hostilities been continued, have been necessary to call a halt between the Dutch frontier and the Meuse until the roads and railways behind them had been repaired. That is to say, it would have been necessary to give the enemy a breathing space, which would have allowed him to restore some sort of order in his ranks and make good his retreat to the Meuse, where he would have been able to establish himself in very strong positions." This, of course, refers to the movement of vast supplies, but tanks operating as described above also are limited in their movements by the necessity of supplies, and it is questionable if these could be provided under the circumstances.

In a defense of this character there are several prime considerations with which one must reckon, the gun is mounted in an entrenched position and is protected by the surrounding earthworks, while the tank must provide its own protection and at the same time maintain its mobility. The gun depends upon auxiliary services for its supply of ammunition, while the tank must carry its supply of ammunition as well as fuel, oil, etc. The gun is practically immune to shell fire in its protected position when compared with the tank exposed in front and flanks to direct fire. It is true that the tank is mobile and may attempt to go forward with a rush and engage the fort at close range, but before it can accomplish this the tank must necessarily run the gauntlet of a heavy fire if the fort is armed as explained above, consequently a direct close range attack is problematical. If the fort is built of a shape which will not permit the tank to enfilade it, the tank will certainly be subjected to worse fire than it can offer in return. No long stretch of the imagination is required to visualize the fort built of such strength that the tank cannot crush it and this will lead to a duel in which the tank will be the loser.

The remedy in this case is to search out the forts with concentrated artillery fire and thus to destroy them, in which case an attack by tanks would be unnecessary. As previously stated, however, this can be answered by artillery fire and gun will answer gun, victory finally remaining on the side possessing the preponderance of artillery.

IT has often been said that the next war will be one in which high speed will be paramount, and that it will be of short duration, but there is a very large school which deems this doubtful. The chances seem favorable to visualizing the opposing armies approaching each other in a very cautious manner, guarding against surprise attacks, and the one will try to out-maneuver the other in order to gain an initial advantage, consequently a decisive victory will be obtained only through a superiority which is both overwhelming and decisive. This overwhelming superiority will not be due to tanks alone, since the enemy will also have these at his disposal, and while the tanks may assist in obtaining the victory, it will probably be due to some flank attack by tanks and for which the enemy has opened the way by leaving this flank exposed to a surprise attack.

There is quite a large school in Europe which insists that a tank attack on machine gun nests can be made effective providing the tanks are accompanied and supported by a large number of machine gunners. If such an attack would follow the thought which engendered it all might be well, or the machine gunners can go forward while the nests are directing their fire on the tanks; however, it is conceivable that the machine gun nests will be supported by infantry, in which case the advancing machine gunners can be picked off by rifle fire while the nests are taking care of the tanks.

This condition has brought about another school of thought, or one which considers guns on one side and armor on the other, in which case this school says the victory will lie with the guns providing the latter are 3-pounders or heavier. As stated previously, it is difficult to provide the tank with heavier armor and maintain its speed and mobility, but a 3-pounder on a self-propelled unarmored mount will be far more mobile than the heavily armored tank.

Quoting Capt. R. Hilton, of the British forces, "A force of mechanized antitank guns, working in conjunction with aircraft, could forestall advancing tanks, even more effectively than machine guns in lorries were able, in the Great War, to forestall advancing infantry." This means that it will be impossible for tanks to advance without the support of mechanized artillery, hence the question is asked, Why under these conditions, armor the tanks at all? The total abandonment of armor is not, however, contemplated but should be used only as an aid to fire-power. In other words, the 3-pounders would be protected with shields which, as regards frontal fire, would be proof against bullets, splinters, and even the fire from 3-pounders providing the latter are not at close range. It is advanced by this school that such a mobile weapon, in relation to the tank, would build up a

much harder striking army because it would possess a far better range of vision, would possess greater hitting power, would be faster, more mobile and, finally, more economical. One serious drawback, exposure to rear and flank fire, is recognized but this is answered by accompanying mopping-up parties of infantry which would be transported in armored cross-country cars.

Such a proposal gives us an entirely different infantry for the future, or one in which fire-power is derived from 3-pounder guns with ability to consolidate the ground.

Quoting further, "In defense * * * the 3-pounder guns would be unshipped and mounted in concealed positions * * * the * * * close-quarter parties would be sited in covered positions near at hand so as to protect the 3-pounders from being run over. A proportion of this new model infantry would be kept in reserve on the hulls ready to launch a counter-attack. The change from infantry fighting of the present day is only one of degree * * * movements will take place at ten or twenty miles per hour. The fire-swept zone will be broader and will be swept by projectiles of 1.5-inch caliber instead of .303-inch. Otherwise everything will be the same. Powerful artillery fire will be necessary to neutralize the defense and allow the new infantry to go forward. Intensive air fighting and counter-battery work will still be required to smash down the fire-power of the enemy artillery."

"The all-armor idea is founded upon a natural desire to avoid heavy casualties, to win battles without bloodshed. Unfortunately this cannot be done * * *. In the warfare of the future, casualties in all arms will probably be very heavy * * * the real difference from wars of the past will be that mechanization will allow all this fighting power to be intensified."

I ONLY mention this to show that everything is not all right even in the birthplace of tanks. It must also be remembered that enthusiasm as regards the effectiveness of the tank was not very high at its birthplace after the war, or after such statistics as I have mentioned were studied. The tank was conceived as far back as 1907-8, but very little development followed because money was not available. Then came the war, and tank thoughts were revived, the experiments made at Aldershot in 1907-8 being recalled. The tank was built in 1915 and found its first use in the following year, but 1917 saw it fighting for its very existence. In 1918 it met with some success, but here we find thoughts as to its effectiveness being again on the decline. The enthusiasts were determined, however, not to permit it to die, hence it became necessary to gain the interest of the public and thus of the politicians. This was done through propaganda.

I quote General Fuller, "The lethargy and opposition * * * were hotly attacked by a small band of tank enthusiasts who saw quite clearly that, as the present age was a mechanical one, it followed of necessity that the army would have to be mechanized. There was no question that this end was assured; in place the whole problem was to speed its advent, so that money might be saved, and what was more important still—casualties reduced during wartime. The difficulties which faced this small band of believers in mechanized warfare was great. First, they were confronted by a solid phalanx of hostile military tradition and secondly, public opinion did not interest itself in the tank. To accomplish anything, public opinion had to be created, and it was considered that it could only be created by press propaganda. To attract the attention of editors, a spectacular machine had to be produced, and the result was that tank engineers set out to quadruple the speed of the old war tanks. This was the wisest step taken, for once a tank was built which moved at twenty miles the hour, its performances were mentioned in Parliament, and the press became interested. Further still, it was essential to show that even the old war tanks did effect enormous economies * * *."

THERE we see the entire matter in Britain based on propaganda with a "spectacular tank" as its foundation. But will the spectacular tank with its high speed overcome the difficulties I have cited? I will leave this for others to decide. What design of tank will we adopt and claim it is what we will require in time of war? And this in view of such tank defense as previously mentioned. It must be remembered that from 1915 to 1918 Britain, with plenty of money and opportunity to try out in actual warfare, not in peace-time exercises, produced a tank which in our present light falls far short of what is required, as is proven by an army possessing large numbers of tanks, which were the last word in 1918, being attacked and defeated by an enemy who possessed no tanks. You may answer that the experience gained during that period points to what is required today, but the war of the future is not today and in the meantime other minds are engaged in solving the problem of defense against what we may consider the object sought by tank enthusiasts, at least I would not place much hope in a "spectacular machine."

In conclusion I will assume a tank constructed so as to be proof against gun fire in so far as its internal organism is concerned, but, and unfortunately, the tracks of the tank, and without which it is immobile, are exposed to a stream of rifle fire, tracer bullets, or thermite shells, and the latter will no doubt be developed. It is not necessary to fire at a range which will occasion a miss, but to wait until the tank is closer, and trained marksmen can then surely place the destructive shell where it will do the most harm, or on the tank's tracks. Should this be a thermite shell the mechanism at the point of impact would instantly become fused, and the tank, as far as mobility is concerned, would be helpless, since it would be converted into a very conspicuous fort which would soon draw hostile fire.

IN all of this I do not wish to create the impression that the tank is valueless, but rather to point out that it possesses severe limitations which tank enthusiasts are prone to pass over. Let us design the proper tank and build what may be necessary, but at the same time solve the problem of what our opponent will do under the circumstances involved in a tank attack, remembering that in all cases final victory will remain on the side possessing the greatest mobility, the greatest striking or fighting power, and the maximum staying power, and that in the last analysis it takes the gun to beat the gun.

It will not be amiss at this point to examine the losses sustained by the British Army in the last war. These losses, as tabulated by General Fuller, give the following casualties:

Arm.	Killed and Died.	Wounded.	Missing and Prisoners.
Cavalry	23.33	66.35	10.32
Artillery	20.37	75.71	3.92
Engineers	20.35	72.46	7.19
Infantry	19.96	64.23	14.81
M. G. Corps	17.27	66.30	16.43
Tank Corps	12.58	70.24	17.18
Other Arms	27.39	65.67	6.94

It will be noted here that while those who were killed or died in the Tank Corps amounted to the lowest in all arms, the 70.24 per cent wounded was but little less than the 75.71 per cent in the Artillery and 72.46 per cent in the Engineers, but higher by 9.4 per cent than in the Infantry and by 6 per cent in the Machine Gun Corps. When we examine the rates of missing and prisoners we find the Tank Corps at the head of the list, or 17.18 per cent; this was no doubt due to the loss of tanks within the enemy's terrain and the impossibility of the men returning to their own army.

One other point must be mentioned and that is the oft repeated expression of von Zwehl, "We were not defeated by the genius of General Foch, but by General Tank," and that of von Hindenburg to the effect that August 8 was the "black day" of the German Army. August 8 refers to the *surprise* attack launched by the Allies at Amiens, where out of 420 tanks 415 got into action and of these 100 were destroyed, while when evening came the remaining 75 per cent of the tank crews were so utterly exhausted that they could go no further. This was all under ideal tank conditions, and *surprise* was the answer to the question.

In view of the tank data presented herewith it is hardly possible to believe these expressions as being engendered by the real thoughts of these men, especially when after the first successful surprise tank attack on November 20, 1917, at Cambrai, the German Army delivered a counter-attack, *without tanks,* and drove the British out of their new positions, to be followed four months later at Amiens, where the British were supported by 370 tanks, and where they were driven back to the gates of the city with the loss of guns, stores and approximately 90,000 unwounded men. It is rather more plausible to assume that these expressions formed an excuse to the German people for the final collapse.

Here we must deal with propaganda, and after so many months of stalemate, with countless dead to be accounted for, it was no wonder that the German public lent a willing ear to President Wilson's policy of liberating *all peoples* from militarism, and this included the Germans. The condition of mind of the German people was further torn to shreds by the continual demands of the militarists, under whose exacting dominion these people had lived for generations, consequently it was no surprise when in July of 1917, or before Cambrai with its tanks, Germany witnessed a revolt in the Reichstag, where a peace resolution which claimed no territorial annexations was passed.

Germany soon learned, however, that no peace would be negotiated with the militarists, hence January, 1918, or seven months before the so-called "black day," saw an attempt at a popular revolt, which was soon quelled by the governing power with promises of success in the coming great offensive. However, the war-weary German soldier was no longer able to stand against the ever-increasing strength and stiffness of the Allies, and the great German war machine began to crumble of its own weight; desertions became numerous, and the higher command was brought to a realization of the futility of attempting further efforts with a dissatisfied and disorganized public at its back; the consequence was the Armistice.

Had the victory been due to tanks there would have been no necessity for so many members of this war machine to seek asylum anywhere but at home, but any excuse is better than none, hence the above expressions.

LET us see what light history sheds on this "black day." Ludendorff was not expecting an attack on this front and its ultimate result was the flattening out of the nose and the indentation of the shallow German salient Arras-Montdidier-Noyon. This required thirteen days, or August 8-21. The British concentrated troops in the area for some days, deceiving the enemy by making all movements by night; the guns were slipped into concealed positions and were fired during the days of preparation with the same rate as before, thus adding to the deception. The blow was struck by the British Fourth Army at 4:20 A. M. on August 8, 1918, and this army had been increased to thirteen divisions, three cavalry divisions, seventeen air squadrons, ten heavy tank battalions, three hundred and sixty tanks, two whippet battalions, ninety-six whippet tanks, and more than two thousand guns and howitzers, including six hundred and seventy-two heavy pieces, while two-thirds of the heavy artillery had been assigned to counter-battery.

The German line was manned by six skeleton divisions, of barely three thousand effectives each, from the Second Army. Not only was the enemy weak in numbers for a fourteen-mile front, but the defenses also were weak with no deep dugouts to retreat to when the British shells struck the trenches. The tanks swept forward, protected by the artillery and surrounded by a thick ground mist, thus effectually making use of the element of surprise.

At the end of the day a penetration of from six to eight miles had resulted, but by the next morning the impetus of the attack died out just about as quickly as it had started. The Germans had succeeded in reënforcing their six divisions with eighteen reserve divisions by August 11, or ten more than the British had estimated. Between August 8 and 12 the British captured twenty-one thousand prisoners at the expense of twenty thousand casualties.

Summarizing this battle we have thirteen divisions, three cavalry divisions, seventeen air squadrons, three hundred and sixty heavy and ninety-six whippet tanks, supported by more than two thousand guns, on the British side, as opposed to six skeleton divisions minus many guns, which had been moved to Flanders where the blow was expected, in opposition on the German side. Twenty-one thousand Germans captured with the loss of twenty thousand British. Where is this great tank victory, and why acclaim this battle as a reason for the existence of tanks? After the British had effectually silenced the German guns, the tanks could advance without difficulty. This seems to have been a tank picnic instead of a tank battle.

References: Tanks in the Great War, Fuller; The Foundations of the Science of War, Fuller; On Future Warfare, Fuller; Canada's Hundred Days, Livesay; The Australian Victories in France, Monash; The Last Four Months, Maurice; The Mechanization of War, Germains; War Memories, Ludendorff; Out of My Life, Hindenburg; *Das Marne Drama,* Hesse.

(*Part II will be published in the July-August issue.*)

Safety in Explosives Operations

The Precautions Taken at Arsenals and Proving Grounds

By J. P. Harris*

THE organized safety movement in Government arsenals and proving grounds is gaining momentum. There has always been a very decided interest on the part of the managements to reduce accidents to a minimum not only because of the monetary loss but also because of the suffering of the persons affected. All claims for personal injuries in Governmental service are handled by the Federal Compensation Board. In the past few years, safety has received the consideration which it warrants. At first, on the part of the employees, the usual opposition to the use of safety devices and practices was met but, with patience and persistence on the part of the managements, this opposition has gradually changed and many voluntary suggestions for safety are now received from employees.

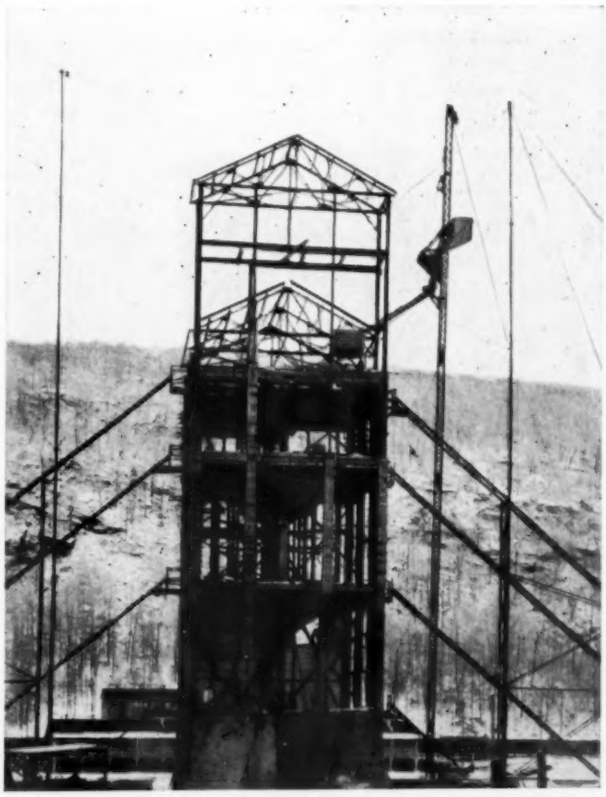
Credit must be given to the large explosives companies in this country for pointing the way to safety in the manufacture and storage of explosives, and to the Bureau of Safe Transportation of Explosives for safety in shipping such materials.

There has been developed by the explosives industry a table of distances known as the American Table of Distances, which, tested by a great many explosions, still appears to cover the ground satisfactorily. It was developed on the basis that a safe distance from an explosion was at a point where no structural damage would be done, i. e., where no main timbers, walls, etc., of structures would be damaged. This table of distances has been adopted by several of the states and enacted into laws regulating the erection and operation of plants for the manufacture and storage of explosives within these states. Some of these laws govern distances from one explosives building to another, as well as from explosives buildings to highways, railroads, etc.

The American Table of Distances covers only those classes of explosives and loaded components, such as blasting caps, which are dealt with commercially. At the time the table was compiled, there was no information available on the subject of loading, handling and storing of military explosives and ammunition. In order, therefore, that the Ordnance Department might be in a position to design and erect plants required for the loading and storing of ammunition, considerable experimental work was done at the Aberdeen Proving Ground to determine the destructive effect of the explosion of ammunition and also the distances which one might expect fragments of such ammunition to be thrown in case of an explosion. Based on the information obtained, safety regulations have been promulgated which are now in effect within the Department.

PICATINNY ARSENAL, the ammunition developing and manufacturing plant of the Ordnance Department, is ideally located from a safety standpoint, as it lies in a long, narrow valley. The hills on two sides are most satisfactory barricades and protect outside communities from any serious damage in case of an explosion. This arsenal is now rehabilitated and complies with the best known safety codes. Picatinny is so laid out that the hazardous areas are segregated and separated from the inert areas. As a result a very large portion of the arsenal is practically as safe as other manufacturing plants not in the explosives business.

Picatinny Arsenal is fortunate in having streams and a lake forming a continuous line of water through the entire length of the arsenal. While there is a regular piped water system with water under 80-lbs. pressure, the lake and streams offer a practically unending supply of water for fire protection. Fire-engine connections have been installed at various places along the banks of the streams and lake to which the engine can be attached in case of a break in the water mains. One of the most serious losses in plants of this type during the war came about due to a break in a water main, and the resultant loss of water pressure, caused by an explosion of a car of explosives which was standing directly over a spot where the water main crossed under the railroad. Here again, we find the new layout at Picatinny placing the water lines in such a way that no main is likely to be damaged in an explosion. The entire water system is

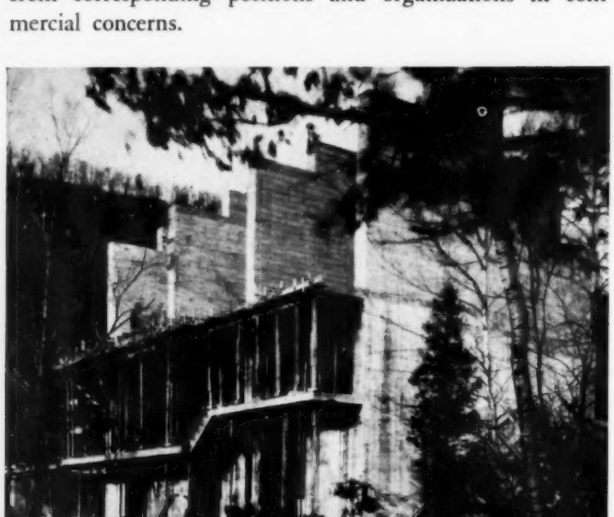


Lightning Masts are an Essential Protection Measure in Powder Manufacture. A Powder Blender Under Construction with Masts in Position.

*Formerly Chief of the Loading Department, Picatinny Arsenal, Dover, N. J. Captain, Ordnance Department, U. S. Army.

so arranged in loops that any portion can be cut out and still receive water from the other end of a loop.

The safety organization at Picatinny consists of a resident safety engineer, a safety board, a safety engineer, a paid fire department and a volunteer fire department. Their duties, generally speaking, are about what one might expect from corresponding positions and organizations in commercial concerns.



In the Modern Powder Plant Partition Walls are of Concrete Construction to Prevent Sympathetic Detonation During Manufacturing Operations.

To clear up a few points which might arise, it might be said that the safety board approves all drawings of new buildings, tools, equipment and modifications of existing units, and sets limits on the number of men and quantities of explosives permitted in any room or building.

The safety engineer inspects all buildings, operations, etc., to see that regulations are complied with; that work is done in as safe a manner as possible. He is free to make suggestions on changes in all phases of the work to prevent accidents and is in charge of the guard force, and the paid fire department.

Each operating department has its own volunteer fire-fighting force and experience shows that this force frequently has the fire under control, if it can be controlled at all, before the paid fire force with equipment arrives at the scene of the fire. Drills in which this volunteer force participates are held at frequent intervals.

THERE are a few problems encountered at Picatinny which should be considered, as most of them are general to all ammunition-handling plants.

It is well known that some explosives have a poisonous effect on personnel. Steps must be taken, therefore, to protect the men as much as possible from coming into contact with the explosives and the vapors given off when the explosives are melted. Effort, without much success, was made during the World War by physicians at the explosives and loading plants to develop some medicine to offset this poisoning. Drinking large quantities of milk seemed to be the most satisfactory deterrent, but, sooner or later, most men employed continuously in this work developed symptoms of poison. The practice has been adopted of examining all persons before employment and allowing no one to work continuously thereafter longer than two weeks in this class of work in a period of a month. These periods are broken by two weeks of other classes of work not in contact with explosives. To detect poisoning before an employee is seriously affected, the hospital personnel at Picatinny determines, once in every four weeks, the blood count of all men working with these explosives. If the blood count is below standard the man is watched very carefully; additional tests are made and if the count continues to drop he is removed from this class of work and is not permitted to return to it until his blood count is again normal. It has been found that employees themselves will not purchase sufficient milk, so the milk is provided free of charge during working hours to anyone employed on this work. To be certain that the necessary hygienic care of regular bathing is taken, a rule has been made which allows everyone working in poisonous explosives to quit work one-half hour prior to the regular quitting time and makes compulsory a shower bath and change of clothing prior to leaving the plant.

A REPORT on the occurrence and prevention of the toxic effect of TNT on human beings at the National Shell Filling Factory in England (war practice) indicates that "the care of the teeth is rightfully considered of great importance. That organization inaugurated a dental department in its plant and required the workers to submit themselves for examination to this department, where the teeth were cleaned, extractions made, and advice and assistance given in other dental work. The categories of so-called TNT poisoning are summarized and differentiated as follows: 1. Toxic: (a) toxic jaundice; (b) applastic anaemia; (c) toxaemia; and 2. Irritative: (a) one form of gastro-intestinal catarrh, and (b) dermatitis.

Toxic phenomena are chiefly due to the inhalation of fumes given off by TNT whether in the solid or molten condition. The fumes in question give a nitrite reaction and are similar in many of their properties to nitrous anhydride.

Gastric catarrh and allied ailments are due partially to the same cause as toxic phenomena and partially to the irritative action of finely divided TNT which is swallowed. Dermatitis is a local irritative action on the skin caused by contact with TNT.

The fumes in question are of considerable density and tend to accumulate close to the floor. They can be removed by suitable ventilating arrangements in which the extracting orifices are arranged at floor level. Efficient and suitable ventilation removes the cause of toxic phenomena and gastric symptoms.

It is essential that only approved operatives be allowed to work with TNT and that suitable steps be taken to ensure that such operatives are well nourished. The earliest possible diagnosis of all suspicious cases is desirable and this can be best attained by a medical officer patrolling the working buildings."

Steps are taken to guard against benzol poisoning. Benzol is a common solvent used in paints and also in recrystallization. Sometime ago a girl operative fainted, with apparently no cause. When the case was investigated it was found that a water-proofing compound which she was using

contained benzol. Arrangements have since been made with the manufacturer of this compound to change the solvent. In paints, benzol very greatly reduces the time of drying but without almost perfect mechanical equipment it remains a very substantial hazard. It is felt that every effort should be made to develop the use of substitute solvents of a less toxic nature wherever this is possible.

Every effort has been made to install sprinkler systems where necessary. Recent tests have shown that most explosions in TNT melting kettles start as small fires, the TNT burns for quite some time (tests show as much as five minutes), and then explodes. It has been found that a deluge of water will extinguish such a fire in the early stages. A deluge system has been installed, therefore, in each kettle.

Accidents at Picatinny Arsenal have been very materially reduced, especially lost time accidents. Men are getting the safety habit! Each new employee is recruited as a student of safety. It has been said that all men are equal in the face of death, but in the explosives business the man who realizes what it is all about and takes the extra risk out of his work has the best chance to cheat the ever present hazard and is the desired employee.

One of the problems always facing the explosives manufacturer is static electricity. Much study has been given to this subject, which is now under intensive investigation. From results of many tests, static electricity of the intensity met with in explosives manufacture apparently will not ignite any of the ordinarily handled military explosives themselves, but there is usually present some solvent vapor or dust which is ignitable and which carries the fire to the explosives and results in the great losses encountered. Consideration has been given to grounding systems but they are rather ineffective. Ionization of air seems to be a solution of the problem, but any apparatus to secure this condition apparently adds an electrical hazard which might be even worse than the original static. Manufacturers, consequently, are hesitant to go to this method until it has been thoroughly tested and proved. The large electrical companies are being consulted on this matter. Progress has been made by the cotton, silk and paper industries in the elimination of static and it may be that the system used by them will apply as the solution in the explosives industry. In this system the static charge is neutralized by an "electric breeze" created by the use of a high voltage, low amperage, current.

A great deal of thought and study has been given to the subject of lightning protection. There is a wide difference of opinion as to the best method of protection. Installations now is use are the old type of rods or cables with grounds of various kinds. Some of these are quite efficient in terms of resistance; generally speaking, the resistance runs less than 50 ohms. Tests of these systems are made at regular intervals to insure good grounds. Consideration has been given to the pole or mast system and also to the cage system. Large oil companies seem to be favoring the cage system, but they have a very expensive and concentrated storage and are not obliged to have the required lines and masts scattered over miles of territory such as is the case in large explosives plants.

There is circulated to all employees holding supervisory positions at Picatinny what is known as the "safety scrapbook" in which are pasted newspaper clippings relating to accidents which might be met with in the routine work.

A safety trophy is presented to the department with the greatest percentage reduction in lost time accidents during each six months' period.

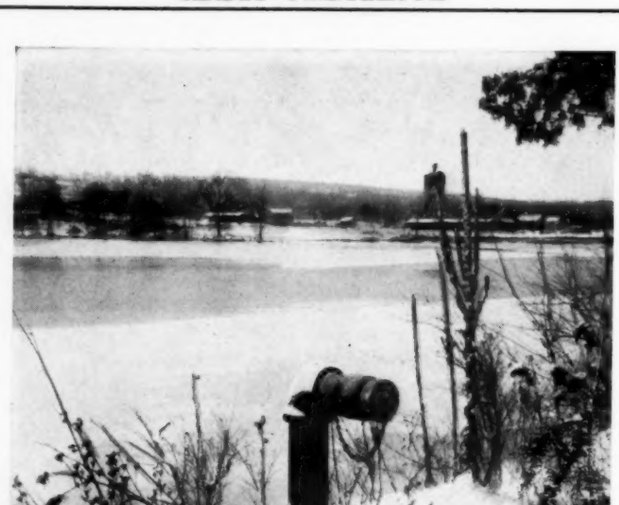
THE operation of a proving ground requires a careful study of operations to minimize the causes of accidents. When it is considered that a proving ground deals constantly with the test of standard ammunition, guns, carriages, tractors, etc., as well as the experimental designs and pilot lots of these munitions, the immensity of the safety problem will be apparent. The greatest length of the Aberdeen Proving Ground runs in a southwesterly direction approximately 18 miles, with an average width of approximately 3 miles. The total area of the reservation is approximately 95 square miles of which 32 square miles is land. Without discussing the organization in general it might be said that the proof department at Aberdeen is the one in which the hazards are greatest. This department performs the particular purpose for which the reservation was created, i. e., the physical testing of all ordnance matériel for both preparation for and development prior to manufacture and acceptance after manufacture.

Safety Chutes Enable Personnel to Slide Out of this Powder Blender in Emergency.

From the gun positions along the main firing front, a land range of 30,000 yards can be obtained while from a special range devoted to the tests of railway and seacoast artillery, the same land range is available, and in addition, a water range up to 60,000 yards. To observe firing at the long ranges, towers are located at intervals along the eastern shore of the Chesapeake Bay for a distance of 25 miles from the firing point. At each of these fronts a tower is provided, from which, through communication systems, safety control is exerted during firings. Before any gun is fired the crew must telephone the settings, etc., to the respective tower and secure permission to fire. Before this permission is given all the data available are checked to insure that the shot will land on Government property at the approximate location desired, or that the ranges are cleared on all water areas involved. To clear the water range it is necessary to have patrol boats, equipped with wireless telephones by means of which they can get in touch with the range towers along the shore and the main tower at the water front. Colored flags are hoisted on the fronts to indicate that tests are being carried on under varying conditions, i. e., high explosives tests, plate

tests or current proof tests.

A flying field is maintained for the purpose of testing bombs and for other aircraft armament. Special apparatus and towers for observing the fall of bombs from airplanes are located in a large area at a remote section of the proving ground area. The bombing planes must fly a certain path to the bombing field. They may not fly over the main range, unless a clearance has been gotten from the tower at the front involved. Until they dispose of their load of bombs they must fly over Government property only. A small-arms range of 6,000 yards, made necessary by the increased ranges obtained in connection with the later developments, has been in operation during the past few years.



Fire Hydrants Directly Connected to Lakes and Streams are an Emergency Measure Where Explosives are Manufactured and Stored.

In addition to the facilities for testing artillery and ammunition, special facilities are installed for testing tanks, tractors and motor gun carriages, and various other facilities in connection with test of engines and transmissions.

Bomb proofs, traverses, concrete gun shelters, etc., are provided for observation and test purposes. In some cases guns are tested to destruction in concrete barricades. These tests are made to prove the general construction of a gun, or one metal or treatment of metal against another. When firing high-explosives-loaded ammunition, either in or outside of barricades, the gun crew must take cover.

It might be said that in addition to all this proof work, Aberdeen is a small ammunition manufacturing plant. The personnel there must store ammunition for test and assemble propellent charges. They are often required to handle "duds," which at the best are usually in an unknown condition from a safety standpoint. To determine the cause of the failure, the components are sometimes disassembled. This is always an operation of extra hazard.

Chesapeake Bay supplies a good portion of the fish consumed in the Eastern section of the country, therefore, all of the water area of Aberdeen Proving Ground is open for fishing purposes. Arrangements have been made whereby fishermen are allowed in these areas during certain hours of the days and nights, and whenever any firing is done it becomes a very important task to see that these people are not within the field of fire. All the safety work at the proving grounds is very well organized and covered by complete orders and regulations.

AT the other main arsenals the problems are those usually found in industrial plants where large quantities of interchangeable machined parts, large castings and forgings are manufactured. One exception to this is the Frankford Arsenal, Philadelphia, where small arms ammunition is manufactured and assembled. The explosives handling at Frankford is in excellent condition, all safeguards being used which it is felt are warranted and necessary. The manufacture of interchangeable machined parts means the use of large presses, furnaces and automatic machinery. The hazards met with in the operation of this equipment are quite normal, i. e., they make necessary the proper guarding of belts, shafting, etc., and all moving parts of machinery, in order that operators will not be injured in the course of their employment. It is felt that all of the arsenals are in need of closer consideration in the guarding of the above items, although examination into their injury records does not seem to indicate that there have been an excessive number of injuries from this cause. The hazard is, however, quite pronounced and should be corrected. Several of the States, through their industrial and labor contacts, require commercial concerns to take the proper safeguards along this line, and require frequent inspections. While Government arsenals are not subject to this industrial inspection, every effort is made to maintain a condition which, from a safety standpoint, is equal to that found in privately-owned plants under state supervision.

It will be noticed that a considerable portion of this paper has been devoted to the conditions at Picatinny Arsenal. This is accounted for by the fact that it is with this arsenal that the author is most familiar and further that the problems encountered at Picatinny are such that they compare most favorably with the problems of all other establishments of the Ordnance Department. Field Service depots are principally depots in which are stored large quantities of ammunition and explosives. Although several of them are equipped to do field maintenance work, the safety conditions at these depots are analogous to those encountered at the manufacturing arsenals, therefore, they will not be dealt with individually.

There are several problems, however, which stand out as applying to all arsenals and depots.

The storage of ammunition, as already stated, should be so arranged that the quantities in buildings and the relation in distance of one building to another should comply with the laws and Ordnance safety regulations. Care should be exercised in the storage of different components of ammunition to insure that the classes of hazards are segregated. This subject is dealt with very completely in the Government manuals on Safety and Storage for Explosives and Ammunition. Consideration should be given to construction of magazines to eliminate therefrom all unnecessary inflammable material. The use of steel and concrete and other noninflammable construction should replace wood wherever possible. Studies have been made of crates and boxes for ammunition and the storage of ammunition from a fire standpoint. This applies especially to the storage of

large demolition bombs. Much can probably be accomplished by the use of metal crates. If wood crates are used it is felt that it probably would be better to remove the bombs from the crates and store them separately, replacing them in the crates when required for shipment.

SMOKELESS powder constitutes one of the greatest hazards from a storage standpoint, due to the fact that it is subject to deterioration and at the best cannot be expected to have a life greater than about twenty years. To detect deterioration and the rate thereof, observation samples from each lot of smokeless powder and ammunition containing smokeless powder are maintained in the magazine and most of the Field Service Depots are equipped with surveillance ovens in which tests can be made at stated intervals on all smokeless powder at the depot. Master samples of all lots of smokeless powder are under constant observation in the laboratories at Picatinny Arsenal. Should any of these samples indicate rapid deterioration, notification is given at once, and steps are taken to use this deteriorating material within a very short period, if possible, or else to withdraw it from service. The surveillance of smokeless powder is covered completely in pamphlets.

Another problem incident to the storage of ammunition is that arising from exudation in shells, especially in the tropics, in which some portion of the bursting charge is TNT. Generally exudation is easily detected by a visual examination as the exudate works its way through the threads of the closing plugs, or adapter-boosters and runs down over the outside of the shell. Cases have been known, however, where exudation exists in shells without the appearance of exudate on the outside. Great care is necessary in issuing ammunition to the service to guard against this condition as the exudation may be such that the explosives charge is honeycombed or otherwise depreciated to such a point that a premature burst will result with the possibility of blowing up a gun and injuring or killing the gun crew.

To guard against the issuance of ammunition from war reserve which might be badly deteriorated, tests are conducted at stated intervals at Aberdeen. These represent a percentage of the complete number in storage, and the tests offer the best solution available to insure the issue of only good ammunition to the troops. If any defective ammunition is found during the test, the complete lot comes under suspicion and appropriate steps are taken before issue.

In view of the large amount of deteriorated war reserve ammunition it has become necessary to recondition large quantities of the materials in storage. Plants are in operation to take care of this work. While many of the conditions here encountered are standard practice at Picatinny Arsenal in the loading of new ammunition, the tearing-down processes are even more hazardous than the first manufacture. Utmost care is exerted in the design of equipment, buildings, barricades, etc., and of all safety appliances in the actual operations. Several accidents in salvaging units were due either to carelessness or poorly designed equipment and layout, but these occurrences emphasize the fact that the salvaging of ammunition is a very hazardous task.

Practically all arsenals engage in painting various components and in these operations the trend is toward the use of spray equipment. This is especially true in the use of lacquers as the best results have been obtained with the use of a spray gun. The hazards involved in this work are such that they have been called forcibly to the attention of the various State industrial commissions. Much literature has been published on this subject and the fire underwriters have promulgated strict regulations on paint spraying and spray booths.

Space will not permit a full discussion of all of the points brought out in this paper, nor many more not mentioned at all. It is hoped, however, that enough has been disclosed to indicate that safety in munitions establishments is of the highest importance. Safety is not a remedy for sickness but a medicine for prevention. What can be more profitable than the saving of human life?

Sea Warriors of the U. S. Navy at Rest off Balboa, Canal Zone.

Taking the Profit Out of War

Necessity for Central Control and a Fixed Price Pattern

By Bernard M. Baruch

I TAKE it that we are of the common belief that war ought to be avoided if possible, but that we must plan in such a way that if war comes we shall meet the enemy with our maximum effectiveness, with the least possible injury and violence to our people, and in a manner which shall avoid inflation and waste. Our plans should eliminate war profiteering, and they ought to provide that each man, thing and dollar shall bear its just proportion of the burden. They should be designed to avoid the prostrating economic and social aftermath of war, and finally they should be laid with full recognition that modern war is a death grapple between peoples and economic systems, rather than conflict of armies alone, and to that end we should merit for industrial America something of what Field Marshal von Hindenburg, in his retrospect of the World War, had to say of its efforts in 1918:

"Her brilliant, if pitiless, war industry had entered the service of patriotism and had not failed it. Under the compulsion of military necessity a ruthless autocracy was at work, and rightly, even in this land at the portals of which the Statue of Liberty flashes its blinding light across the seas. *They understood war.*"

PURSUANT to Public Resolution No. 98, 71st Congress, a joint Congressional and Cabinet Commission to recommend war policies began hearings during March, 1931. The commission has invited leading authorities on the economic and industrial aspects of the problem to present their views. In the belief that the experiences and theories of the individuals who appear before the Commission are both of general interest to readers of this Journal and of vital importance to a proper determination of this paramount subject, ARMY ORDNANCE *will publish in these pages the expressed views of some of those who testify. There is presented, with the permission of the author and as the first in this series of informative discussions, the statement of Mr. Bernard M. Baruch, financier and Chairman of the War Industries Board from March 5, 1918 to the end of the World War. The concluding part of Mr. Baruch's statement will be published in the July-August issue of this Journal. Other testimony will be published in succeeding issues.*—EDITOR.

THE principal requirements of your organic joint resolution are that you consider and report whether a Constitutional amendment is necessary:

(1) To authorize Congress to take private property for public use during war;

(2) To remove the profits of war;

(3) To equalize the burdens of war; and

(4) To consider and report policies to be pursued in war.

The Committee is not to consider conscription of labor. For purposes of discussion I venture to paraphrase the subject of inquiry, thus:

"A plan to mobilize effectively the resources of the Nation for war which shall eliminate war profiteering, prevent war-time inflation, and equalize war-time burdens."

I assume that if a Constitutional amendment is not necessary to this end a recommendation of policies is nevertheless desired, and also that such policies should make adequate provision for war profits at a lower rate than peace profits.

Since there was never a war without inflation, profiteering and unequal burdens, the resolution seems a large order, but it is with no hesitation that I can say from our own experience in the World War and from methods that were actually in practice here at its close that the ends sought are possible of attainment and that means to those ends are simple. This is neither dream nor theory. I shall recommend no principle that was not in actual practice and accomplishment in 1918.

Prior to 1870 nations hazarded their existence in reliance on small fractions of their strength. In the Franco-Prussian War, Germany showed some dim conception of what she called the "Nation in Arms" by which was meant that, in war, her entire resources of men, money and things should suddenly become a compact instrument of destruction. The true intendment of this conception was fully grasped by none of the belligerents in 1914 and became clearly apparent only in the last months of the World War.

What it really means is that in the next major conflict the entire population must suddenly cease to be a congeries of individuals, each following a self-appointed course and become a vast unitary mechanism composed, in our case, of some 125,000,000 correlated moving parts all working to the end of directing practically all our material resources to the single purpose of victory. Modern war requires that the full power of the nation be exerted in the shortest possible time not only to the violent beating down of the enemy by any destructive material force we can invent or use, but also to every process of slow and often insidious economic strangulation and political isolation that we can devise and administer.

THE battle field effort (while now only a part of what we shall be called upon to do) has become of itself a monstrous thing. Twentieth century means of transportation, communication and supply have made possible—and therefore necessary—the massing of men in numbers never before deemed possible. The accelerating progress of science has created destructive forces which require for their use or for defense against them the products of practically the whole of industry in quantities many times those required for the

uses of peace. Thus war requires that, at the very moment when productive effort is deprived of millions of men for military service, the country's facilities for production must be speeded up to disgorge unprecedented volumes of supplies. Civilian morale becomes as important as military morale and it is necessary to make this cosmic change with the least practicable interference with the normal life of the nation. Furthermore, the increasing dependence of each principal nation on uninterrupted contacts with practically all other nations entails the necessity—for both offense and defense—of an economic strategy and intense economic tactics which must include practically every other nation—hostile or neutral—in its far-flung application.

No such results as these are at all possible without a sanction, control and leadership in industry sufficient to organize and deal with it as practically a single unitary system instead of a highly competitive community. Once this unity is attained, however, experience has shown beyond question that the mobilized industry of America is a weapon of offense or defense far more potent than anything the world has ever seen—more terrible, I think, than the mind of any man has ever imagined.

War on this vast modern scale has hitherto so violently disturbed the pattern of the normal economic structure of belligerent nations that, regardless of the side with which rests military victory, the aftermath of struggle prostrates both the conquerer and the conquered. With these most serious considerations you must deal. They depend on principles which we seem loath even to talk about—much less to provide for. These principles, while generally conceded in a vague uncomprehending way, are hardly understood at all. Yet they are of such sinister and overwhelming importance that the neglect of them is, in my opinion at least, one of the most threatening aspects of our governmental policy. From my experience I am convinced that it is quite possible to prepare, in peace, plans that will make the transition from peace industry to war industry with minimum disruption, to carry on the feverish industrial activity of war with the least possible harm to civilian morale, to accomplish all in the economic struggle that we shall ever need to accomplish and, even with all this, to lessen the destructive after-effects of major conflict. It is for these reasons that I regard the work of this Commission very seriously and that I am much gratified to be able to lay before it the results of the experience of the War Industries Board in the World War.

THE following sequence has attended every major conflict in history:

(1) Shortages of services and things develop rapidly.

(2) Competitive bidding among the procurement agencies of government and, in the last war at least, other procurement agencies, and for the civil population send all prices into a rapidly ascending spiral.

(3) Expenses of government multiply. The abnormal need for money requires vast issues of certificates of governmental indebtedness. The inherent threat of destruction of government impairs national credit. The combination of all these things rapidly debases the exchange value of money thereby still further increasing the prices of things. The consequent destruction of buying power in the markets of the world begins almost immediately to impair the economic strength of the nation in the conflict. This sapping of economic strength will, in future wars, be the determining cause of defeat. As Ludendorf has so bitterly complained his military front remained impregnable long after what he called "the home front" had crumbled. Destruction of civil morale defeated Germany.

This process intensifies as time elapses with the following inevitable results:

(1) Destruction of domestic morale through a just and bitter resentment by soldiers, their families (and indeed by all persons of fixed income) at the spectacle of grotesquely exaggerated profits and income to those engaged in trade or in services for sale in competitive markets and the constantly increasing burden of bare existence to all those who are not so engaged. This is the greatest source of complaint of "unequal burdens." The present demands for "equalizing burdens" and "taking the profit out of war" both go back to this single phenomenon of war inflation. There is no more important problem to solve—whether we consider it purely as a means to maintain the solidarity and morale of our people, or as the basis of our economic strength for war purposes, or to avoid war's aftermath of economic prostration, or on the broader grounds of humanity and even-handed justice.

(2) The inflationary process affords opportunity to individuals and corporations to reap profits so large as to raise the suggestion of complacency if not of actual hospitality toward the idea of war. That any human being could be persuaded, by prospect of personal gain, however magnificent, to invoke the horrors of modern war is almost unthinkable, nevertheless the certainty that war could never result in the enrichment of any man would give us all security and comfort.

(3) Inflation enormously increases the cost of war and multiplies burdens on the backs of generations yet to come. The war debt of the nation is necessarily incurred in terms of debased dollar values. In the inevitable post-war deflation the debt, of course, remains at the inflated figure. Thus the bonds that our Government sold in the World War for fifty-cent dollars must be paid through the years by taxes levied in one hundred cent dollars. For example, our total war expenditure was $39,000,000,000 incurred in terms of 1917, 1918, 1919 and 1920 dollars. In terms of the purchasing power of 1913 dollars it would have been only $13,000,000,000, or in terms of 1930 dollars probably not more than $15,000,000,000. Such a grotesque result would be almost unbelievable were the figures not living facts. If anything can be done to avoid this practical doubling of the economic burden of war certainly we should spare no effort to accomplish it.

WHEN we entered the World War, the frantic demands and uncoördinated counterbidding of our future associates in war had already distorted our own price structure out of any semblance of its normal scheme. In other words, there was a robust inflation here before we ever entered the war. Furthermore, nearly twelve months elapsed after our declaration before we had evolved controls and organization capable of coördinating our own and our associate's procurement activities and of controlling price. Notwithstanding this delay and the dimness with which controlling principles were at first perceived, we did, in

1918, arrive at a method which checked the process of inflation in America and kept it in check until all controls were released in November, 1918. It is to this experience that I refer when I say that we have proved in practice a method to control inflation. That proof convinces me that it would also prevent inflation if applied at once upon the advent of war and before the inflationary process begins.

To measure inflation of price and profit we must have some norm. The obvious norm is the whole price structure as it existed on some antecedent date near to the declaration of war on which the normal operation of the natural law of supply and demand can be said to have controlled price. That determined, we need a method of freezing the whole price structure at that level. The obvious way to do this is simple—by proclamation to decree that every price in the whole national pattern as of that determined date shall be the maximum that may thenceforth be charged for anything—rents, wages, interest rates, commissions, fees—in short, the price for every item and service in commerce.

In these few words reside the basic principle of war control of national industry and of the present suggestion for elimination of war inflation in America. The superficial objection is—"You propose to repeal the law of supply and demand." We may as well take this bull by the horns. In modern war administrative control *must* replace the law of supply and demand.

In the national pattern of peace, all economic forces are operating under the work-a-day influences of that natural law. Prices, production and finance all are factors of competition—in other words, of that law. But in peace, the various parts of what will eventually be the economic engine for war are neither coördinated nor subject to any single guiding control. Indeed, to prevent such combination and control is the basic effort of peace-time administration.

Suddenly war appears. The whole tempo, volume and quality of the force of *demand* becomes distorted. Things that yesterday were of no great importance (e. g., toluol, picric acid and sodium nitrate) suddenly become the aim of all endeavors. As to these as well as to all other fundamental commodities there is an almost instantaneous shortage. Now, in peace-time shortage, the highest bidder takes all. That *is* the law of supply and demand. In war—at least in major, modern war—we cannot permit this. The government must assume control of the whole supply and ration and apportion it—not to the longest purse but to the most necessitous use. Furthermore, the distinguishing characteristic of peace-time economic operation is *competition,* and basic prices are largely determined thereby. Also it is literally the object of one great competitor to secure as great a proportion of all business as possible. Under war conditions the entire process is reversed. There is more business than all the facilities of the country can handle. Competitors must become coöperators in order to meet the very minimum demand for shortage items. Control of this coöperation rests in government. Thus, both because governmental determination (*and not price*) controls demand, and because only complete coöperation (*and not competition*) can produce supply in sufficient quantity, the law of supply and demand adjourns itself.

These principles apply to shortage items. The crystallized price structure is a schedule of maxima. Items in ample supply are left free to fall below the fixed price level.

FURTHERMORE, this provision, which places control of and responsibility for supply of shortage items in the hands of government by no means solves the shortage problem. Under the law of supply and demand, rapidly increasing demand (and consequent rising price) is the force relied upon to provide increased supply. In war we cannot wait for this, and we cannot stand the waste and confusion incident to it. We must use other means, such as were very fully developed in 1918. By way of introduction, let us name them:

(1) Elimination of waste, loss, and unnecessary accumulation through frantic competition by all procurement agencies, which elimination is achieved by a rigorous control and coördination of them and the funneling of all demand through one central control agency.

(2) Rationing and allocation of shortage items in order that more necessitous uses (such as equipment and supply of field armies) may have priority in time with careful provision against undue hardship to the civil population.

(3) Conservation, by which is meant: standardization of type and design; elimination of any but necessitous uses; prevention of hoarding and accumulation; postponement of all deferrable uses, thus increasing supply by sharply curtailing demand.

(4) Substitution—by which is meant substitution of items of greater availability for shortage items.

(5) Discovery of new sources of supply.

The resiliency of a great people like ours—their capacity to "do without" or adapt themselves to new conditions—makes the potentiality of the above expedients very great. No one who has not seen these expedients in operation would be likely to imagine the vast quantities of essential commodities, power, storage space, transportation, money and labor which can be made available in this way. An explanatory word as to some of these expedients may be in order. Conservation is among the most effective of wartime expedients. Multiplicity of type and design in almost every commodity of commerce wastes a vast amount of component material. Had the war gone on another year, our whole civil population would have gradually emerged (as wardrobes and inventories became exhausted) in cheap but serviceable uniform. Types of shoes were to be reduced to two or three. The manufacture of pleasure automobiles was to cease. Flaps from pockets and unnecessary trim in clothing would have disappeared. Steel had already been taken out of women's corsets.

THE conservation program was, of course, much broader than this. It affected practically the whole field of commodities. We had instituted a deferment of every type of building construction except that indispensable to the prosecution of the war. We had gasless, meatless, sugarless, fuelless days, and in ways and methods too numerous to mention we were greatly increasing the supply for essential uses by cutting off supply for nonessentials.

Yet after all these things are done there will remain unavoidable necessity for adjusting the crystallized price structure upward in individual cases. We always have low-cost producers and high-cost producers. War requires *all* producers. This presents the most difficult aspect of the problem:

"If we raise the price sufficiently high to pay a reasonable

profit to the high-cost producer we will thereby create inordinately high profits to the low-cost producer."

There are only two alternatives—create a system of bonuses to the latter class or limit, by an excess profit tax, the return on invested capital to the former class. After exhaustive study during the war, the former method was considered impracticable and the latter was adopted. The most cogent objection to it is the great variety of accounting systems and the consequent confusion and opportunity to conceal profit. Due to the income tax and the increasing ownership by the public of the securities of great corporations accounting is now much simpler. Some of the difficulty still remains but it is a hindrance—not an insuperable obstacle.

Besides the necessity of revising some prices upward there will also be a variety of occasions for revising others downward. A method must be devised to adjust the initial frozen price pattern to the changing situation.

We did this during the war by a Price Fixing Commission which reported directly to the President who passed final judgment and announced the price. There was nothing in the experience of that Commission to suggest that a similar system would not be entirely effective in the future.

The frozen pattern of price will also have to be protected against the situation in export trade. If, as is almost certain, the inflationary process is in operation in the rest of the world, means will have to be applied to prevent extravagant foreign prices from upsetting our domestic schedule. Government, in its world economic strategy, must have almost plenary control over foreign trade. We shall see the agency for such control purchasing for export at the controlled domestic price, selling in export at world price and using the profit to buy necessitous imports at inflated world prices and sell to domestic needs at the controlled schedule.

Of course the basis of the present suggestion is price fixing. The student of the economic history of war will say "There is nothing new about this. Every nation with a debased currency has tried to force acceptance of it at a fiat figure. None ever succeeded."

ONE did succeed. It was the price-fixing policy of the World War. The distinction between that and previous attempts was that, for price fixing in 1918, the whole of industry was mobilized and under control of government in a sense never even imagined in any other country or in any other war. This I shall later demonstrate. Another distinction between all previous attempts with which I am familiar (including that of the World War) and the present suggestions is that what is here proposed is that we apply the organization and methods developed in 1918—not *after* rampant inflation has run away with our economic structure—but at the very outset.

As illustrative of these distinctions, New York, in the Revolution (1 Cook's New York Laws, 1780, p. 210) enacted a law by which the profits of manufacturers, wages of mechanics and laborers and the prices of a long list of commodities were fixed at a figure *"not to exceed twentyfold of the prices paid in 1774"*—the latter date was taken as reflecting the normal operation of the law of supply and demand and the "twentyfold" as measuring the debasement of the Continental currency. Here was an attempt to check inflation *after it had occurred*. The basic idea is the same as the one here suggested, except that we now propose to check inflation *before* it occurs.

Similarly, in the 1917 Food Control Act, profits in July, 1914, were set as the maxima for war-time profits of bakeries. The New York price fixing was a failure. The Food Control Act succeeded. Why? The former was a fiat with no adequate means of enforcing it. The latter was backed by the whole system of licensing, commandeering and regulating powers slowly evolved by our War Administration.

A re-creation of that administration at the very outset of another war would insure the success of the suggestions here advanced.

YOUR resolution requires you to recommend policies to be pursued in event of war. President Wilson once stated such a policy thus:

"The power against which we are arrayed sought to impose its will upon the world by force. To this end it has increased armament until it has changed the face of war. In the sense in which we have been wont to think of armies there are no armies in this struggle. There are entire nations armed. Thus the men who remain to till the soil and man the factories are no less a part of the army that is France than the men beneath the battle flags. It must be so with us. It is not an army that we must shape and train for war; it is a nation."

In specific terms, what we seek is:

(1) The adequate supply to our fighting forces of every item in the vast congeries and astonishing volume of things required for modern armies, navies and air fleets, *when they want it, where they want it and in the quantity they want it.*

(2) Provision to meet this tremendous additional task of our industry without undue dislocation of its normal functions and without too rigorous deprivation of our civil population.

(3) Maintenance of superiority of economic strength *vis-à-vis* the whole world to the end that we may not fail in the economic struggle which in modern war has become almost, if not quite, as vital as military conflict.

(4) Avoidance of the economic and social aftermath of war.

We have already lightly touched some of these subjects. Some repetition is necessary. I shall endeavor to keep it at a minimum.

The first problem is how to mobilize our industry.

Industrial mobilization requires:

(1) The creation of a central control agency charged with the entire problem of industrial mobilization. It must:

(a) provide an immediate and effective organization of both supply and demand;

(b) insure proper functioning of the interior control of each such organization and constantly regulate them both;

(c) bring them together, compose their differences and insure the uninterrupted flow of goods from one to the other.

IT IS impracticable to maintain in peace any such powerful agency as is necessary in war to administer the gigantic effort of national economic mobilization. We should prepare a complete plan for such an organization but even that must be in the broadest of terms. It is impossible to foresee the precise circumstance and requirements of any

future war. Perhaps a skeleton organization might be provided for—merely to insure the development of a personnel. The Congress has attempted to do this by making the Assistant Secretary of War responsible for making plans for industrial mobilization. Devoted work has been done in the War Department but there is some danger in this method. It is absolutely impracticable for the War Department to control industrial mobilization because:

(a) It is an economic problem requiring the ablest leadership in industry and utterly unsuited to military administration.

(b) The central control agency must act as arbiter of conflicting demands—the greatest of which is that of the civilian population. No single competitor such as the War Department should be entrusted with such arbitration.

(c) The job of the War Department is our armed forces. That is a big job. To pile on top of it the task of economic mobilization would insure the failure of both.

There is an inevitable tendency in the War Department to forget these principles even in planning. Their function is to say what they want and when and where they want it. The job of industrial control is to see that they get it strictly on their specification. We must neither militarize industry nor industrialize the army. While I do not advocate change in the present law, the facts just stated should forever be borne in mind.

These and other considerations are of equal force against any thought of calling upon any peace-time agency to assume this task. Our industry must, at last analysis, mobilize itself. What is required is leadership of a type that will persuade coöperation in every branch. This leadership must be backed by sanctions of far greater force than can or ought to be used in peace. It is a spontaneous sort of function utterly inappropriate to any imaginable form of bureaucratic organization.

THE War Industries Board was slowly developed by a method of trial and error during the war. Its organization was as follows:

The Chairman. All the power of the War Industries Board and complete and undivided responsibility for the performance of its tasks were vested in the Chairman.

The Board was composed of the heads of its grand divisions plus a representative of the Army, the Navy, and Labor, a legal adviser, and, when necessary, the heads of other war administrations were called in—they were always in intimate contact through representatives on grand divisions of the Board or otherwise.

This organization was created on the principle "Committees for counsel—a single responsible head for action." The Board members had no vote. The object was to obtain their views, to discuss their problems in common council and to coördinate their action. As a matter of practice there was never a lack of unanimity and the Chairman never was called upon to overrule a member. This organic principle was carried down through every committee and commission of the Board. The chairman of each was individually and solely responsible and he had undivided authority. As some one has facetiously said this principle kept the Board from being long and wooden.

The very essence of the Board's positive control of industry lay in three of its functions:

(1) The determination of priorities;
(2) Its exclusive control over commandeering;
(3) Power to fix the price of basic commodities.

Priorities. The government, through the Railroad Administration controlled transportation. Because of the power of government to commandeer supplies and facilities (in some small part definitely expressed by statute delegating some of it to the President and, in large and completely comprehensive part, generally known to reside in Congress) every producer in the country was aware that failure to coöperate with the war measures of government might, and very probably and promptly would, result in the appropriation by government of all that he had. These two sanctions enabled government to obtain complete compliance by industry with the orders and regulations of the Board.

Practical regulation was achieved as follows:

Principal shortages were in transportation, power, fuel and basic raw materials. In general, the Board prescribed that nothing of these and the other shortage items should be furnished by a supplier to any manufacturer who did not have a so-called priority certificate. To obtain such a certificate of any grade, every manufacturer had to make to the Priority Division of the Board, a satisfactory showing that his proposed use of these materials was one determined by the Board to be essential to the winning of the war.

The flexibility of this system was very great. Priorities could be granted to whole classes of industry or they could be restricted to only a few producers. Priorities were graded from those of the most urgent necessity to those only slightly preferred to normal uses. One of the essential conditions of any priority order was that the recipient must agree to abide by all governmental regulation on pain of forfeiture of his priority.

The priority system proved effective beyond the hopes of its proponents. It affords a method of almost instantly marshalling the industries of the country and thereafter synchronizing and controlling their operation in a far more effective way than if the government were in actual control and operation of any of them.

The criterion of the priorities administration was that of relative essentiality. Its power to support essential industry and to curtail or cut off less essential uses was very great. By such curtailment or suppression, it released vast quantities of supplies, labor, transportation, power and money to necessitous uses. By the very complete conspectus of relative need and available facilities and supplies which necessarily developed under its hands, the Board was enabled to know very definitely the location, size and emergency of most of its major problems. By the utter dependence of both supply and demand on priorities, regulation and coördination of both was greatly facilitated. It rendered relatively simple that which (at first sight) seemed complex beyond hope of effective administration.

Other methods of control were used by other war administrations—the most usual being the licensing system typical of Food Administration practice. In this case the statute required a license by the Food Administration to certain classes of manufacturers and distributors of food and it was unlawful for these classes to do business without such license. Like priority orders, these licenses were granted only on condition that the recipient would abide by governmental regulation and were always revocable.

This system accomplished the same ends as the priority system, but I have always regarded the latter as the more flexible.

Commandeering. A true basis of our control of industry was the latent (and in part expressed) power of Congress to commandeer. Portions of this power had been expressed in statutes and delegated either to the President or to other agencies. There was some initial confusion in the exercise of these delegated powers (or the threat of such exercise) by uncoördinated users of it. The President finally ordered that no commandeering order should issue without approval of the Chairman of the War Industries Board.

This provision is absolutely essential. The final essence of control of all industrial activity must be lodged in a single responsible pair of hands. If there be one single authority charged with

(a) Determination of priority;

(b) Commandeering;

(c) Price-fixing;

then the details of the integration of various war administrations become of less importance and a great flexibility is permissible.

Thus in 1918 we had nine major war administrations. Each of them reported separately to the President. Each was set up independently of the others. The War Industries Board administered everything not controlled by others. For example, one of its functions was control of the iron and steel industry. It is difficult to see why that industry should have been treated in a manner different from that used for the fuel industry. In strict theory, I suppose it could be said that proper coördination and control would have dictated the grouping of all these administrations into a single central control agency for war administration.

As a matter of practice no conflict ever arose. I attribute this to the fact that in the War Industries Board were centered the essence of all control—commandeering, priority and price-fixing. All the administrations were in the hands of very capable men. Methods did not differ greatly. The whole structure was synchronized and coördinated by the fact that essential control in the three functions just named was centered in one place.

The actual process of commandeering was simple. A commandeering committee was set up to determine the question of just compensation. It was provided that every commandeering order should be signed by the Chief of the Priority Division (representing the Chairman of the Board) and by the Army and Navy representatives on the Board.

In practice the power to commandeer was very rarely used. It remained in the background as the effective persuasive force which vitalized the whole program of regulation.

Price-fixing Commission. The Price-fixing Commission included the Chairman of the War Industries Board, the Fuel Administrator, the Labor Member of the Board, a member of the Tariff Commission, representatives of the Army and the Navy, a representative of Agriculture, and the Chairman of the Commission.

In practice, prices were fixed by agreement. When a necessity arose to consider a price the expert staff of the Federal Trade Commission was called in to investigate costs. The particular branch of industry affected was represented either by the appropriate war service committee, hereinafter described, or otherwise as it should elect. Organized demand was represented by the appropriate commodity committee of the Board and the procurement officials directly affected. The Commission itself sat in a quasi judicial capacity. While doubtless the resulting "agreement" as to particular price schedules was somewhat influenced by the latent control of the Board there has never been, to my knowledge, any charge that prices so determined were either discriminating or unfair to industry on the one hand, or burdensome and extravagant to the public interest on the other. Prices were fixed for stated periods and subject to revision on hearings.

The President finally passed upon the agreed price and announced it to the public.

With the whole price schedule crystallized at the outset, as is here suggested, the function of the Commission would come into play only when necessity appeared for changes in the fixed maximum prices. Price control would be much simplified.

Commodity Committees. Industrial production falls into two natural classifications—raw material and finished products. The Board had a division for each. The head of each division had under him a group of so-called commodity committees—one for each principal grouping of commodities. There were in all 60 of such committees. In the raw materials division, for instance, there was one committee for iron and steel; one for each copper, zinc and brass, one for each of the ferro alloys, one for each principal metal and chemical and so forth throughout the whole list of raw materials. Under the Commissioner of Finished Products there were similar committees for finished goods, as, for example, one for each: machine tools, cranes, chains, boots and shoes, cotton goods, and so forth throughout the whole list of products.

Each committee was composed of a chairman expert in the subject assigned to it but divorced from financial interest in any company within it. Representatives of each procurement agency were members and also such assistants as the chairman or chief might choose. The method of functioning of these committees is more fully described under the heading "Organization of Demand." Briefly, each of them was assigned responsibility for supervision of both organized supply and organized demand in the subject assigned to it. They studied requirements, investigated sources of supply, suggested conservation, priority, curtailment and price schedules, worked out means to increase supply or render it more available, brought supply and demand into contact, allocated facilities, regulated prices in contracts and were responsible for delays in production due to failure of transportation, power and fuel, raw material or labor supply. Most problems were settled by conference between those affected but where something more was needed, each committee was merely auxiliary to the grand divisions of the Board and, at the call of the chairman of the committee, the whole vast power of the Board was instantly available to him. The commodity committees were thus the working points of the grand divisions of the Board, just as those grand divisions constituted the support and sanction of the commodity committees.

(The concluding part of Mr. Baruch's statement as presented before the War Policies Commission will be published in the July-August, 1931, issue of this Journal.)

Antiaircraft Gun Control

Part I: Defense Against Air Raids

By Roswell H. Ward*

THE potential power of bombing aircraft, as a raiding force against large cities and army areas, has made defense against air raids a major military problem. This description of the Sperry antiaircraft gun control system is prefaced with a brief outline of that problem.

It is generally recognized that air raid defense plans require a special degree of consideration because of the unique opportunity which air raid operations present for an enemy attack on public opinion. There is no other military force which can so powerfully influence civilian morale. Hence, in addition to planning antiaircraft defenses for weak points in the army front, such as airdromes, rail-heads and command posts, a high command may anticipate a widespread need for the organization of defenses against air raids, to protect interior areas of a combatant nation within bombing distances of hostile air bases.

This need is caused not only by purely military considerations, but also by the popular fear of air raids which has been built up through the public press. This popular apprehension may not only undermine the civil morale in the face of air raids, but may also bring about a serious diversion of air forces under pressure of public opinion.

IN the popular mind at present there is just one defense against air raids—defense air forces. There will be, in war, a very definite limitation on the number of combat airplanes and pilots available for service. This limitation will be especially evident in the early phases of an operation because a very high type of intelligence, physique and training is needed to qualify pilots for air combat duty, and because the sources of supply of present highly specialized types of combat airplanes will not have had time for necessary wartime expansion. In contrast to this limitation of combat air forces, it may also be anticipated that commercial aviation will supply an enemy with a group of trained cross-country pilots capable of carrying out bombing missions.

The primary purpose of pursuit or combat air force units is combat duty with the army in the field. A high command will strain every nerve, in event of war, to strike at an enemy's greatest air strength with the largest combat air force it can mobilize. Hence, the limited number of combat airplanes and pilots available cannot be diverted to an immobilized defensive rôle to protect interior areas against air raids, when every dictate of strategy compels their immediate use to contest the mastery of the air and gain security for the army in the field.

An enemy will probably be under the same limitation as far as combat air forces are concerned, but the diversion of commercial aircraft and pilots to military duty implies no such handicap in conducting bombardment missions.

Therefore, unless ground defenses are available effectively to combat air raids on interior areas and the general public is fully informed as to their value, it is very probable that consistent air raids, planned solely to influence the civilian populace, could bring about a dangerous division of air forces under pressure of public opinion, and result in the diversion of large numbers of fighting aircraft to ineffective defense duties.

This diversion of fighting forces by an enemy attack on civilian morale has many historical parallels. An excellent

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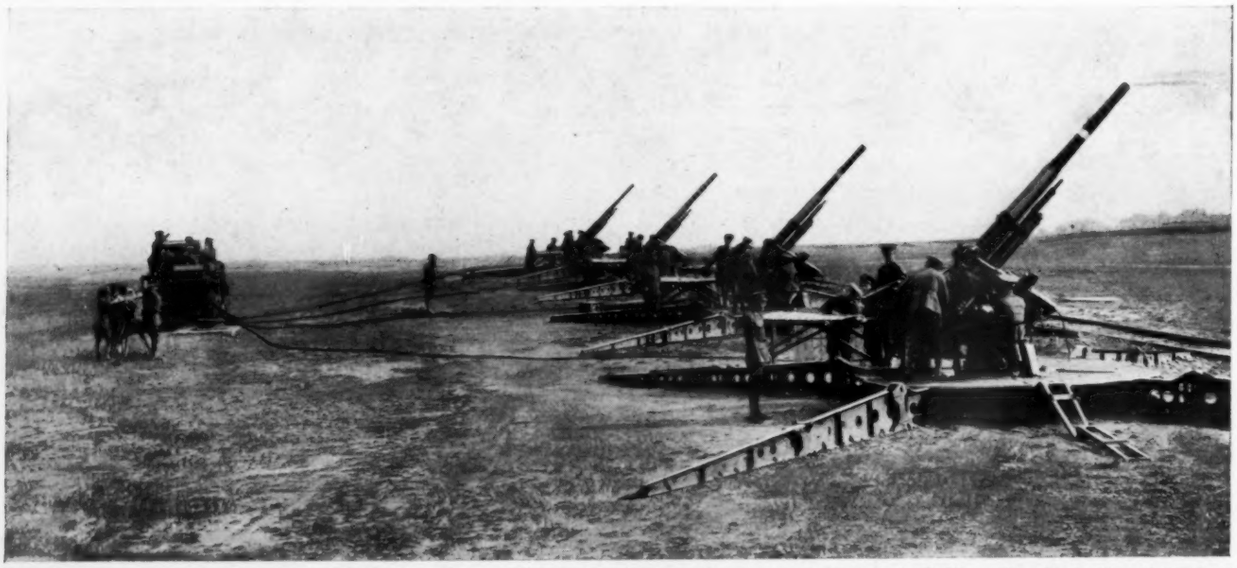

Fig. 1. Ground Defense Against Air Raids is Needed to Protect Vulnerable Areas; to Support Civilian Morale; to Guard Against Diversion of Air Forces Under Pressure of Public Opinion.

Fig. 2. Defense Against Air Raids is a Major Military Problem.

example of such an attack on public opinion, with forces which were intended solely for that purpose, is found in the record of the German submarine demonstrations off of the American coast in the first days of American entrance into the European War. No actual German submarine raids took place on the American coast for several months, but merely the *threat* of German submarine attack, fostered by strong propaganda effort, had such a profound effect on public opinion that the antisubmarine forces of the Navy were held on the Atlantic Coast for several months, forcing the Navy to violate, under pressure of public opinion, that fundamental principle of military strategy which calls for an immediate concentration of fighting forces in the critical area—the "front"—whether it be on land, at sea, or in the air.

The actual damage done by the German submarines that did attack in the Western Atlantic probably put out of action not more than 150,000 to 200,000 tons of shipping of little military value. In contrast to this, it was estimated that from 2,000,000 to 3,000,000 tons of vitally needed supply and transport shipping of the Allies were sunk in the Eastern Atlantic in the period when the convoy system was delayed by the diversion of American antisubmarine forces. With such tremendous losses resulting from diversion of forces by propaganda alone, and with a public mind apprehensive in regard to air raid hazards in *peace*, the effect of air raid propaganda and well organized enemy morale raids in war may be very serious if adequate and well recognized means for ground defenses against air raids are not available.

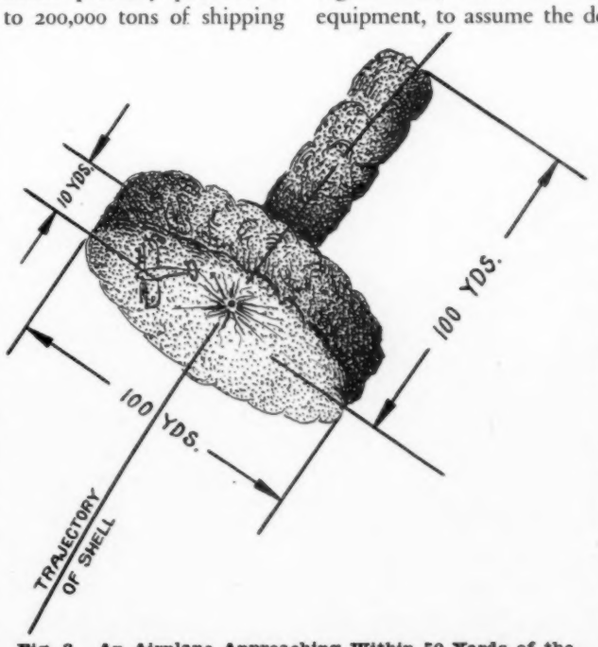

Fig. 3. An Airplane Approaching Within 50 Yards of the Point of Burst of a 3-inch High Explosive Shell Will be Within the Destructive Zone of the Burst

To support and maintain the civilian morale; to protect army areas and interior centers of supply, transport, and administration; to guard against diversion of combat air forces by pressure of public opinion; and to permit the use of relatively untrained men under intensive mobilization conditions, there is a very definite need for ground defenses against air raids. (Fig. 2.)

This necessity has not been entirely recognized or met in the past because of the limitations of the earlier types of antiaircraft guns and gun control systems and the consequent tendency to turn to the airplane for defense against airplanes. However, the marked improvements which have been made in antiaircraft equipment and methods of gun control, in which the Sperry Gyroscope Company has taken a prominent part, now make it possible for an antiaircraft organization, armed with modern guns and gun control equipment, to assume the decisive rôle in the all-important defense against air raids.

IN outlining the progress achieved in the recent intensive development of antiaircraft artillery it will be well to examine its basic feasibility in its most elementary terms. In the abstract sense there is nothing to prevent an attempt to intercept a hostile airplane, if one can keep it under observation long enough to lay the guns on it and subject it to an intensive fire.

A heavily loaded hostile bomber, operating from a base probably several hundred miles away, is limited in the elevation it can reach by the weight of its load of bombs and fuel, by the need

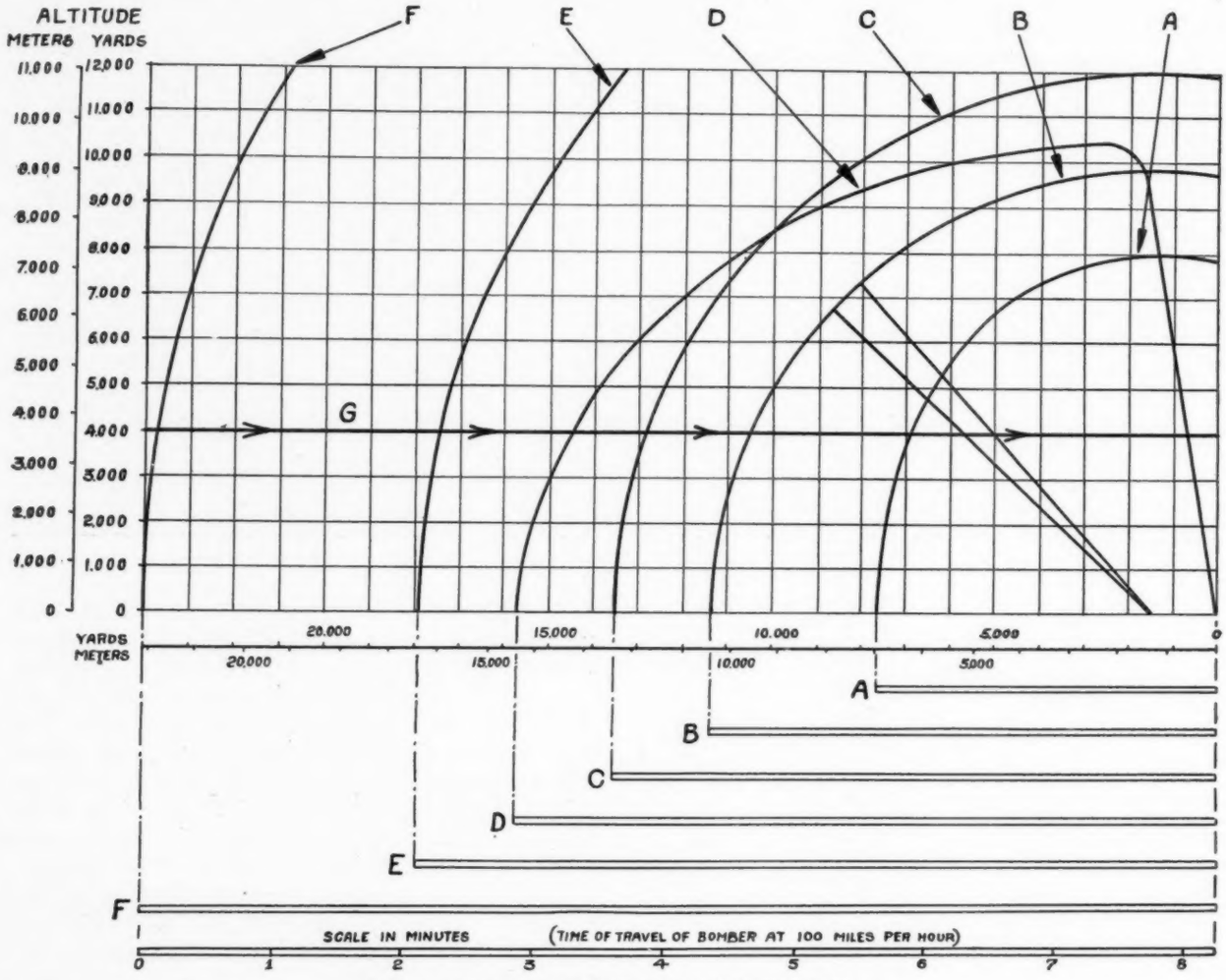

Fig. 4. The Time Limitation in Antiaircraft Fire.

Illustrating the maximum periods of time within which a bomber flying at a speed of 100 miles per hour will be within range of an antiaircraft battery. A. Maximum time within zone of effective fire—2½ minutes; B. Maximum time within range of 60-inch searchlight—4 minutes; C. Maximum time within effective sound locator range—5 minutes; D. Maximum time within envelope of trajectory of 3-inch gun—5½ minutes; E. Maximum time within visual observation range under conditions of ideal visibility—6 minutes; F. Maximum time within limits of audibility with sound locator—8 minutes; G. Path of bomber flyng at 100 miles per hour at 12,000 feet altitude.

for observation of the ground to insure accurate navigation when near its objective, and by the necessity of accurately placing its bombs once that objective has been reached.

In most instances its mission will be a failure if it cannot select a definite target, adjust its bomb sights on that target, and adhere to a fixed course and altitude long enough to drop its bombs in accordance with the conditions imposed during the preliminary sighting operation.

If the bomber chooses to dive on the target, it jeopardizes its safety and the accomplishment of its mission by making its bomb sights ineffective, by approaching a greater and greater density of antiaircraft fire from long range artillery, and finally by coming within range of the antiaircraft machine gun batteries.

It might be assumed that if the attacking bomber is bent only on influencing civil morale, by indiscriminately dropping bombs on a large city, that the bomber would not have to select a definite target. World War experience demonstrated that indiscriminate bombing of this character is ineffective as by far the greater portion of the bombs fall in open spaces or else in sparsely populated areas.

The bomber, to be effective, will have to approach close enough to be seen in daytime or to be within searchlight range at night. There is thus a probability that under most air raid conditions the defense gunner will be able to see his target.

It must be borne in mind also that the defense gunner is firing on a fragile target, using high explosive shells which have a widespread burst (Fig. 3) that will destroy an aerial target which approaches within a radius of 50 yards of the shell at the point of explosion. The thickness of the burst at this point is about 20 yards, except for the area closest to the path of the shell, where the dangerous density of shell fragments extends in the form of a cylinder about 100 yards long and 20 yards in diameter, the shape of the burst being roughly similar to that of a mushroom with the stem turned away from the point of the explosion.

THE foregoing discussion outlines a need for antiaircraft ground defenses, and a basic feasibility of such defenses which has been recognized by military authorities since the pioneer days of military aviation. The following outline

defines these problems and illustrates the principles utilized in their solution.

The gun control problem of the antiaircraft gunner is the only artillery problem in which *time* plays a major part in the solution. In firing on a fixed target on land a gunner needs only to determine the position of the target in two dimensions. In firing on a moving target at sea the gunner determines the position of the target in two dimensions and, having found its rate of movement along an observed course, introduces an element of *time* to determine a future position where the projectile and the target will meet. He is dealing with three dimensions, of which time is one.

The antiaircraft gunner, however, because he is firing on a target moving in space, must define its position in three dimensions, and then introduce a "fourth dimension" of *time* which will permit him to predict the future position of the target, once he has ascertained its course and rate of movement along that course. Because of the speed of an airplane target—a bomber moving at 100 miles an hour is traveling at 50 yards per second—the *time* dimension is the controlling factor in computing a point where the target and the projectile will intercept, and accuracy in antiaircraft fire is much more dependent on the introduction of the time dimension than in other artillery problems.

Time is not only a basic element of the antiaircraft gun control problem proper, but it also exerts a marked influence on the method of solving the problem. We have already shown that the target is moving at high speed—and that time is one of the four dimensions needed to compute its future position—but the high speed of the target also makes it necessary for this computation to be accomplished in the shortest possible interval between the moment when the target is first observed and when the gunner opens fire on it.

Experience has shown that the entire period of time available for observation and fire on an airplane target does not exceed eight minutes and usually, especially at night, does not exceed four to six minutes. (Fig. 4). In this short period the antiaircraft gunner must not only ascertain the present course and speed of the target in three dimensions, but he must also introduce the time dimension and predict the target's future position; compute the ballistic data necessary to insure intercepting it at that future position, and accurately and continuously perform all of these operations in the face of the most drastic limits on the time available for gun control computation and actual fire on the target.

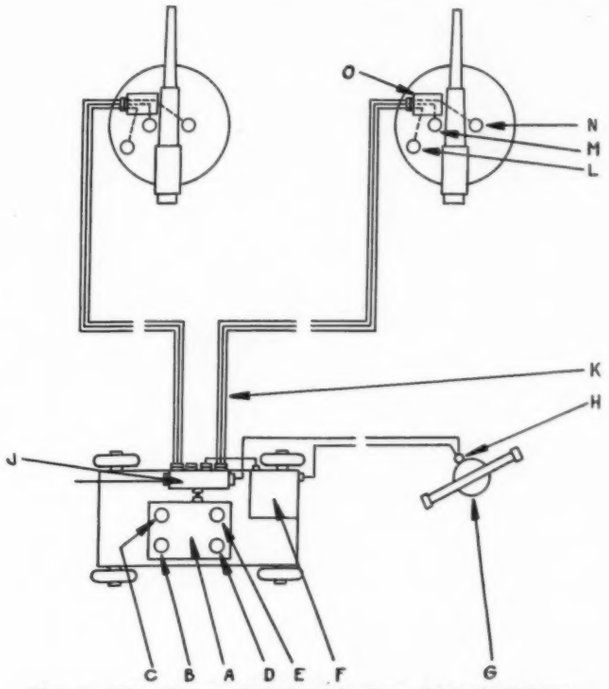

Fig. 5. The Sperry Antiaircraft Gun Control System.

A. Computer on trailer; B. Fuze setting transmitter (within computer); C. Quadrant elevation transmitter (within computer); D. Azimuth transmitter (within computer); E. Altitude Receiver (within computer); F. Power plant on trailer; G. Height finder; H. Altitude transmitter on height finder; J. Transmission system junction box on trailer; K. Data transmission cables; L. Fuze setting receiver on gun; M. Azimuth receiver on gun; N. Quadrant elevation receiver on gun; O. Transmission system junction box on gun.

To meet the time limitation as far as the guns are concerned, well known quick firing methods have been utilized, which permit a modern 3-inch mobile antiaircraft battery of four guns to deliver a combined fire of 100 shots per minute. Each one of them—representing a complete solution of the four dimensional antiaircraft problem—will be approaching a hostile target at intervals of less than 1 second between shots. Marked improvements have also been made in the muzzle velocity of modern antiaircraft guns, so that the range of the guns considerably exceeds the greatest distance that a target could approach and still be visible.

To control the fire of these guns—to predict the position of the rapidly moving target and compute and correct the gun angles necessary to insure intercepting it—to transmit these gun angles and the fuze setting to the guns in the shortest possible time—and to enable the gun crew to receive these data and train the guns within the same time limitation—the Sperry system of automatic data computation and transmission has been evolved which effectively introduces the important "time dimension" and accomplishes the entire gun control computation almost instantaneously.

Briefly the system (Fig. 5) consists of a height finder, electrically connected to a data computer, which is fitted with telescopes for tracking the target in azimuth and elevation, and with means for introducing other data required in the solution. These two instruments predict the future position of the target, make all ballistic computations and corrections, and electrically transmit the resulting gun angles and fuze setting to indicators on the guns comprising the antiaircraft battery. The gun pointers and fuze setters in turn have only to "match the pointers" on the indicators to lay the guns and set the fuzes, no demands being made on their individual judgment under air raid conditions.

The heart of the gun control system is the computer. It comprises two coöperating groups—(1) the mechanism for solving the ballistic problem, (2) the mechanism for resolving the velocities of the target and for predicting its movement in space in such manner as to permit intercepting it with a bursting projectile.

The ballistic problem is concerned solely with the trajectory of the projectile. If the trajectory were a straight line from the muzzle of the gun to the target, the ballistic problem would not exist. However, due to the influence of gravity the trajectory of the shell is curved, so that the gun

must be raised *above* the angle of sight, representing a direct line to the target, in order to make the trajectory pass through the target. The angle to which it must be raised above the line of sight is called *superelevation* (Fig. 6).

For the same reason, the distance in a straight line to the target is not an accurate basis for setting the fuze, inasmuch as the shell will take longer to follow the curved trajectory rather than a straight line. The time required for the shell to reach the target is called *time of flight.*

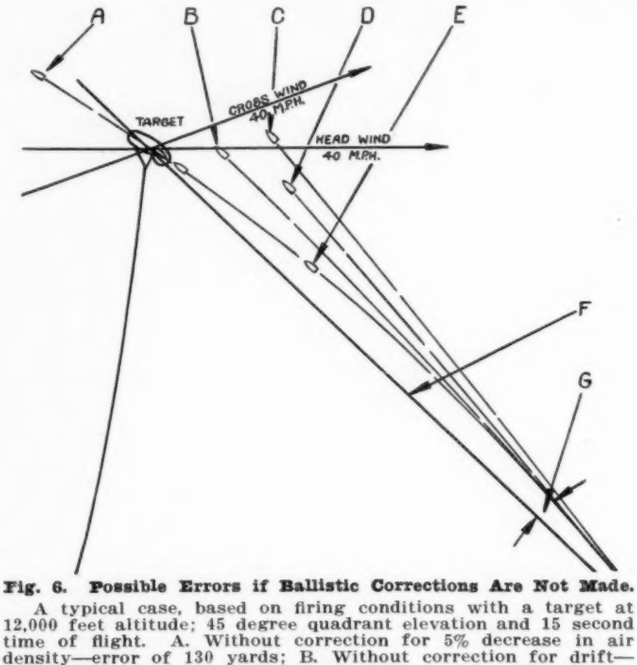

Fig. 6. Possible Errors if Ballistic Corrections Are Not Made. A typical case, based on firing conditions with a target at 12,000 feet altitude; 45 degree quadrant elevation and 15 second time of flight. A. Without correction for 5% decrease in air density—error of 130 yards; B. Without correction for drift—error of 30 yards; C. Without correction for 40 mile per hour cross wind—error of 90 yards; D. Without correction for 40 mile per hour head wind—error of 30 yards; E. Without correction for 100 feet per second change in muzzle velocity—error of 110 yards; F. Line of sight to target; G. Angle of super-elevation.

Firing tables have been prepared which show the *normal* superelevation and *normal* time of flight for any point in space, these tables being calculated to set the gun angles to allow for the curve in the path of the shell under assumed "normal firing conditions"—which assume an ideal condition of no wind, standard air density and standard muzzle velocity of the gun.

It is therefore necessary to add or subtract corrections to these *normal* values of *superelevation* and *time of flight,* which will compensate for the influence of wind, changes in air density, and changes in muzzle velocity of the gun. These elements (wind, air density and muzzle velocity) change from day to day or from morning to night and must be individually determined and compensated for. If any one of the corrections is not taken into consideration, its absence *alone* would be sufficient to cause the shell completely to miss the target.

The ballistic problem is solved by the use of the Wilson-Sperry ballistic cam system—a "mechanical firing table" which is described in the following brief outline.

THE ballistic mechanism of the computer is used together with the means for determining the course and speed of the target and for predicting its *future position.*

There are several methods available for carrying out such a prediction. Two of the methods are: (1) observing the rate of change of the line of sight to the target, i. e., prediction by angular velocities; or (2) reproducing the movement of the target mechanically within the instrument and measuring its rate of movement along two axes at right angles to each other.

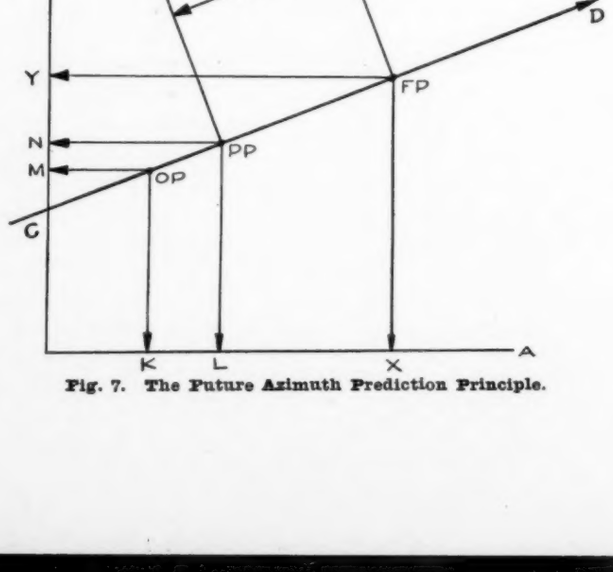

Fig. 7. The Future Azimuth Prediction Principle.

This second method, called prediction of horizontal range or prediction by rectilinear coördinates, is used in the Sperry computor because it eliminates the element of compromise which exists in the angular velocities method. It is one of the unique features of the Sperry system and does not introduce the errors possible if the prediction is based on the changing angles of the line of sight as viewed from just one point.

Once the course (C-D, Fig. 7) of an airplane target has been determined in relation to two reference axes (A & B) and, by observation of its progress between two observed positions (OP & PP), its speed has been broken down into two component rates along these arbitrary East-West and North-South lines (rate of movement on A axis from K to L and on B axis from M to N), its future position (FP) at any time, in relation to these axes, can be predicted by using the simple formula: *"Rate* multiplied by *Time* equals *Distance."* Distance in this case being the distance (LX & NY) which the target will move along each of the axes in reference to which its future position is predicted.

For instance, if the course of the target is such that it is advancing along the East-West axis (A) at 50 yards per second, its position (FP) ten seconds in the future will be 500 yards further on the East-West axis. Determining the rate of movement along each axis and multiplying these rates by ten seconds will give two reference points (X & Y) on the East-West and North-South axes which will accurately define its position after that period of time has elapsed, no matter what the angular course of the target happens to be.

The time element, by which these component rates must be multiplied to obtain a prediction, is determined by the time of flight mechanism so that the shell will burst when it intercepts the path of the target. It is evident that the time of flight of the shell — from the instant when it leaves the gun

until it bursts—must be the same as the time required for the target to reach the point where their path's intercept. The present *time of flight* has already been computed by the ballistic mechanism and it is this time of flight which is multiplied by the component rates to begin the prediction cycle.

While the time of flight used in its initial introduction into the prediction cycle is the time of flight to the *present* position of the target, its introduction starts a flow of data which instantaneously corrects the prediction to indicate the *future* position of the target, and then continuously indicates that position from then on. This "flow" of data is obtained by virtue of the close interlocking of the ballistic and prediction mechanisms—the prediction causes a change in the time of flight—this new time of flight changes the prediction—and these two trains of data flow together to calculate the continuously changing *future* position of the target.

The prediction principle so far described gives the angle of train or azimuth of the gun (after the angle obtained by

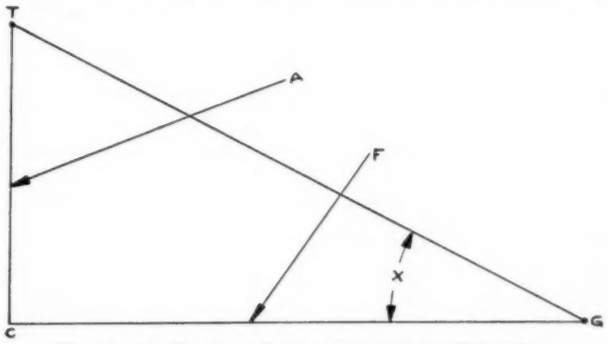

Fig. 8. Prediction of Future Quadrant Elevation.

the prediction elements has been corrected by the ballistic elements), and also the fuze setting—which is also corrected by the ballistic elements. The elevation of the target must also be predicted and is accomplished by the following method (Fig. 8).

The altitude of the target has already been determined and fed into the computor and the *future horizontal range* of the target has been determined by the prediction mechanism. If the altitude (A) is visualized as a vertical line from the target (T) to a point directly below it on the ground (C); and the future horizontal range (F) is assumed to be a horizontal line from this point to the guns (G), it will be seen that two sides of a right triangle have been defined.

With these two sides known—and actually reproduced to scale within the computer—the angular height of the target (X) can be directly measured. This *future angular height*—the angle of sight of the future position of the target from the guns—is then acted upon by the ballistic elements of the computer, which add to it the proper super-elevation and ballistic corrections to give the actual *quadrant elevation* of the guns.

WITH these basic problems and principles of solution in mind, we may define the requirements for a modern antiaircraft gun control system as follows:

Automatic Computation: The use of automatic mechanical computation is essential to obtain an automatic and instantaneous "flow" of gun control data to meet the drastic time limitations of, and incident to, antiaircraft service.

Accuracy of Prediction: The experience gained in earlier gun control developments has shown that accuracy can best be achieved by the use of a method of predicting the future position of the target which eliminates all of the mathematical compromises heretofore attempted.

Complete Ballistic Corrections: A similar inadmissible source of compromise exists if an attempt is made to introduce intermittently the various purely ballistic corrections required, such as corrections for wind, air density, muzzle velocity, and drift, without making allowance individually and continuously for each of these factors.

Reduction in Number of Guns per Battery: Since the deciding factor in antiaircraft fire is the number of hits registered in a given length of time, the enhanced accuracy of the improved gun control system should make it possible to reduce the number of guns used in the typical tactical unit from four guns to two guns per battery and still maintain a high degree of fire power. This will result in substantial savings in the first cost of the equipment; will permit a better distribution of antiaircraft units when a limited number of guns is available; and will make possible considerable economies in ammunition expended.

Reliable Data Transmission: Once the above requirements have been satisfied by the use of an automatic and mathematically accurate and complete method of gun control computation, the resulting gun angles and fuze setting must be transmitted to the guns by a method of transmission which is absolutely reliable and capable of operating under rigorous field service conditions.

Ability to Anticipate Movements of Target: The gun control system must be completely under the control of the battery commander and, in view of the increasing maneuverability of modern types of bombing airplanes, it must be possible for him instantaneously to anticipate and compensate for diving or other maneuvers on the part of the target without affecting the normal prediction and correction functions of the system.

Ability to Fire on Ground Target: In view of the present degree of mobility of all units of an army, it must be possible for the gun control system to direct the fire of an antiaircraft battery on a ground target. This will permit it to meet any emergencies which may occur if the battery is in service with combatant troops and is subjected to an attack by armored cars, ground forces, tanks, or motorized artillery.

Minimum Dependence on Training of Crew: There should be a minimum of dependence on the human element; on the training of the gun control crew; or on their exercise of judgment under air raid conditions. All operations must be made as mechanical and fool-proof as possible; training requirements must visualize the conditions existent both in active peace-time service and under rapid mobilization.

Mobility and Independence: The gun control system must be able to accompany an army in the field as a motorized unit, with the ability to traverse rough roads and go across open country as effectively as other motorized units; it must be entirely self-contained and weather-proof; and it must be possible to set it up in a period of time not exceeding the time required to set up the antiaircraft guns which it serves.

Checking the System: It must be possible to check the accuracy of the system in the field without special equipment.

(*To be continued in the next issue of this Journal.*)

The New "Ace" Colt Automatic Pistol

Operations in Manufacture of the Caliber .22 Long Rifle Arm

By Harry Stevens*

THE purpose of the development of the new Colt "Ace," caliber .22 pistol is to furnish the owner and prospective owner of a caliber super .38 or Government model .45 automatic pistol the opportunity of procuring an automatic pistol for target practice, having the same grip, trigger pull and safety features as the standard .38 and .45 at considerable less cost for ammunition.

In the development of a pistol for the use of the .22 long rifle cartridge, several important problems had to be solved and difficulties overcome. These include: (1) variation of breech pressure in the many caliber .22 long rifle cartridges produced commercially, the pressure varying from 12,000 to 20,000 pounds per square inch. (2) The weight of the

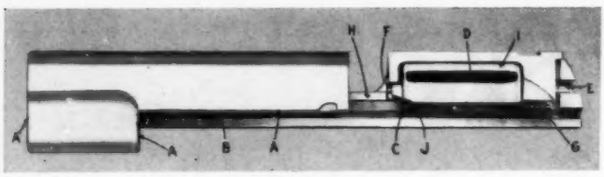

Fig. 1.

moving parts together with the recoil necessary to operate the pistol, particularly with smokeless powder loads. (3) The development of a magazine which would be positive in feeding the smaller cartridge and positive in operating the slide stop after the last cartridge has been fired, as in the case of the caliber .38 and .45 pistols. (4) The manufacture of a super-precision barrel, light weight slide, and other parts. These are described in detail and indicate the development of what has been acclaimed the finest pistol placed before the public in recent years.

In Fig. 1 is shown the slide forging made from a bar of solid stock, trimmed and heat treated, after which it is sent to the machining department.

The first machining operation (a) consists of milling the bottom and front ends and the rear of the recoil spring housing, after which the barrel hole (b) is drilled and finish reamed. After these operations a small hole is drilled and reamed in the rear end of the slide in perfect alignment with the barrel hole, thus establishing the locating points from which all subsequent operations are machined and gaged. The receiver ways (c) are roughed out on milling machines and finished on a profiling machine to a limit of .003-inch from the barrel hole and .002-inch in width.

The firing-pin hole (d) is drilled and reamed locating from the barrel hole to assure proper position. The extractor hole (e) is drilled in a deep hole drilling machine, in a fixture which locates the hole in the proper position from the barrel and firing pin holes. The cartridge-head cut (f) is positioned from the barrel hole and must be kept in alignment with this hole to prevent crowding the cartridge when entering the chamber.

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The disconnector cut (g) in the bottom of the breech block must be positioned very accurately to prevent the hammer from falling before the breech face in the slide is seated against the barrel at the rear end. Consequently this cut is positioned from the face of the breech block in the slide. The weight of the slide, of course, affects the recoil and several cuts are made to lighten its weight. These include cutting out in the top of barrel hole (h); shortening the front end of the slide and milling out excess stock (i) on both sides of the firing-pin hole.

An angular cut (j) is made on the front end and bottom of breech block to allow the top cartridge in the magazine to feed up gradually as the slide recoils to the rear thus controlling the action of the magazine spring against the possibility of prematurely forcing the cartridge through the lips of the magazine. (See also Figs. 4 and 5.)

The superprecision barrel, Fig. 2, is made of a high-grade steel, rolled to special shape with lug on the bottom. The lug is an integral part of the barrel.

The first machining operation after cutting and heat treating, is the removal of excess stock in front of the lug (a) after which the barrel is rough turned on the rear end (b) in deep hole drilling machine to fit the bushing. The drilling is done at the rate of ¾ of an inch per

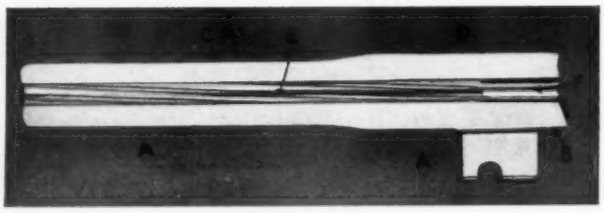

Fig. 2.

minute with special drills used on this type of machine. There is a small oil hole through the drill for forced lubrication. The oil is driven by a pump yielding a pressure of 500 lbs. per square inch, sufficient to force chips to the rear and out of the barrel. Allowance of .010- to .012-inch is made for three reaming operations and one burnish reaming operation. The outside diameter (c and d) is turned on hardened steel plugs and later ground to limit of .001-inch on another set of hardened plugs. The remaining operations on the outside are finished from the bore before the bore is burnish-reamed to final size. The rifling operation (e) is performed on a Pratt & Whitney rifling machine to a depth of .0035-inch with diameter across rifling plus or minus .0005-inch.

The experience of the Colt Company in making barrels for revolvers and pistols has led to the belief that the rifling should be twice the width of the land and the spiral should be one turn in 14 inches on a .22 caliber. These conclusions have been reached after very extensive tests. The width of the rifling cutter is never reduced more than .003-inch and this in the course of producing several thousand barrels or

the entire life of the rifling cutter. Rifling cutters should be ground on the outside to produce a uniform depth of rifling in the corners as well as in the center. We therefore grind our cutters on centers and to a size equivalent to the diameter across the rifling.

In determining the chamber dimensions tests were conducted to ascertain the exact size which would best seal the chamber at the bottom with the expansion of the casing by the powder gases and not require an excessive amount of pull by the extractor in withdrawing the empty casing from the chamber. The chamber (Fig. 2, f) is therefore from .002- to .003-inch larger at the bottom than a loaded shell, with a

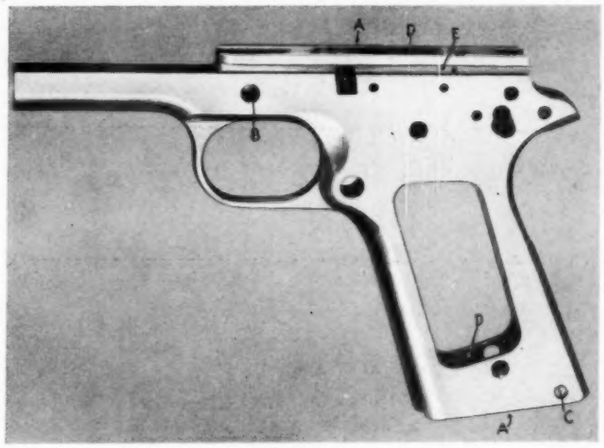

Fig. 3.

taper of .005-inch in the diameter toward the rear. The strain on the extractor after starting the empty casing rearward is thus reduced with the attendant retarding of the slide, which would occur with a straight chamber.

Grooves are cut in the barrel to hold the ejector in the proper relation to the chamber and the ejector point at a fixed distance from the rear of the barrel, which is about ¼-inch greater than the loaded length of the cartridge.

The receiver, Fig. 3, is identical with the Government and commercial model, and is a solid forging weighing three pounds, seven ounces weight. When finished it weighs eleven ounces. The total amount of metal removed from forging to finishing is 44 ounces, or 88 per cent. The material used in the receiver forging is 1035 S. A. E. and forged in our own forge shop, as are all other forgings used on Colt pistols and revolvers. The company is in constant touch with the conditions under which the forgings are made.

The first operation after forging and heat treating is grinding the sides to a working thickness after which the top, bottom and front end are rough milled leaving an extension at the top and bottom of the magazine hole (a) at right angles to this hole for the purpose of broaching at a later operation. Following this, holes (b and c) are drilled and reamed to a working size in a jig from each side to assure proper location. These holes are used wherever possible as working and gaging points in the various machining operations. The remaining holes are located from these working holes. Therefore they must be placed accurately as all parts assembled in the receiver as well as those in the slide must interchange.

In removing the metal in the magazine hole we first drill a hole which forms the front of the finished hole, then remove excess stock on the sides shown in cut (d), after which we pencil mill the remainder of the stock at top and bottom, leaving the cut a half circle at the rear as well as in front. We are now ready to run the broach through, finishing the sides and rear wall with sharp corners. After this operation the top and bottom are finish machined as shown in Fig. 3. The slide ways (e) are finished to limits of .002-inch from hole (b) to insure the proper fit of the barrel when assembled to the receiver with slide. The barrel differs from the .38 and .45 in that it does not move in and out of locking cuts in the slide with a toggle action as is the case with the larger caliber guns.

The barrel-seat cut must be made to the correct size from hole (b) as the slot in the lug of the barrel is positioned to provide a close fit between the leg on the slide stop and the rear of the cut in receiver. The cuts in rear of the receiver are made, locating from holes (b and c) and are held in keeping with the interchangeable conditions required. To complete a receiver, over one hundred operations are required and at the finish inspection 75 per cent of the operations are inspected 100 per cent and the remaining 25 per cent are inspected one piece in each rack of thirty. In addition our system of manufacturing requires each operator to gage two pieces in each rack of thirty receivers and twenty slides at the time when the operation is performed.

The magazine, Fig. 4, a vital factor in the successful operation of this type of automatic pistol, required considerable planning and experimentation before its design was definitely decided upon.

The fact that a magazine as large as the caliber .45 required changing in such a way as to adapt the caliber .22

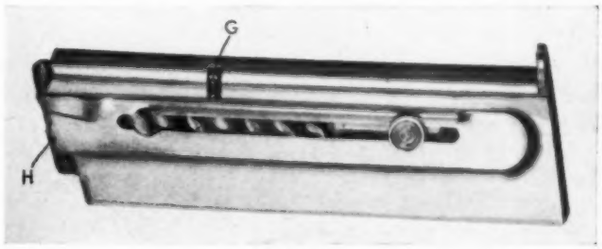

Fig. 4.

long rifle cartridge, which has a head considerably larger than the body; also that the width of the large magazine is so much greater than the length of a caliber .22 long rifle cartridge, and the additional consideration that the angle of the grip was best suited for the caliber .45 naturally increased the obstacles to be overcome.

It was decided in our experiments to take up the extra width of the magazines by a filler piece, Fig. 5, by making a blank large enough to draw in the sides the required amount necessary properly to guide the cartridges, without affecting the fit of the magazine in a caliber .45 Government model receiver.

After determining the size and shape of blank to be used, a punch and dies were made to form the magazine to shape. This is done in two operations, the first being the bend to form the back (a), the second being in a "U" shaped die which completes the shape ready to weld to the corner (b). After welding, the excess stock on the outside is removed by grinding and excess stock inside at the

corner being removed by passing a broach through, which removes the excess stock only.

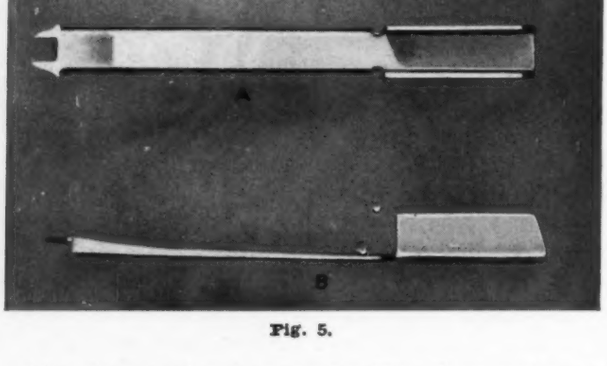

Fig. 5.

After this operation the magazine (Fig. 6) passes through a multiple trimming die where the top outline (c), is formed and the cut in bottom (d) for magazine base is made.

The next operation consists of drawing in the sides at (e) and forming the lips (f), which is done in one operation by a specially constructed die. Next, the slot (Fig. 4, g) for the catch is punched and the ears (Fig. 4, h) are formed after which the filler piece is inserted.

In Fig. 6 the magazine is shown with a section of one side removed showing the position of each cartridge. The different positions will be more readily observed by comparing the angle at which the bottom cartridge lies with that of the top cartridge. This change of position is caused by the shape of the filler piece and accomplishes the purpose of changing the position of the cartridges as they feed up from the natural feeding angle in the magazine to the best suited operating angle for entering the chamber of the barrel.

The filler piece is blanked out of sheet steel .050-inch in thickness and is formed to shape after which it is inserted into the magazine forming the rear wall of the cartridge compartment. It is held in position by the formed ears of the magazine at top (Fig. 4, h), the magazine base at bottom, and between the rear wall of the magazine and the rear of the formed portion shown at Fig. 6, e.

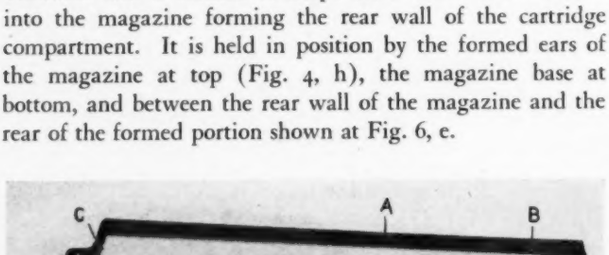

Fig. 6.

The magazine follower, shown at Fig. 6, j, also is made of sheet steel, blanked and formed with the left front side milled a part of the way down from the top to operate the slide stop (after the last cartridge from the magazine has been fired or removed from the gun) by holding the slide open and the action disconnected.

The parts assembled in the slide differ from those used in the caliber .38 and .45 models. The ejector is fastened to the barrel instead of to the receiver; the firing pin is made in two pieces to allow assembling and to prevent the front end of the firing pin from coming in contact with the top of the chamber in the barrel when dry shooting; the firing pin hole is enlarged at the rear, and a collar is left on firing pin, thereby making a positive stop for the forward movement of the firing pin.

The firing pin stop is slotted to carry a roller which rolls lengthwise along the face of the hammer, thus reducing the friction while cocking the hammer by the rearward movement of the slide after firing. The firing pin is prevented from turning by means of a pin in the firing-pin, which fits into a groove in the bottom of the firing pin hole in the slide. The extractor is a duplicate of the caliber .38 and .45 models with the exception that it is thinner since less tension is required to hold this cartridge.

The front sight is of Patridge type 1/10-inch thick and is made high enough to use a rear sight with vertical adjustment of 1/10-inch as well as a windage adjustment.

The action, with the exception of the mainspring, is indentical with the caliber .38 and .45 models. The sear, hammer, disconnector, sear spring, trigger, mainspring housing and grip safety are hand-finished, giving this model an additional smoothness which appeals to the owner. The hand-finishing of these parts may be of interest. After the nose of the sear is filed to the exact thickness for required trigger pull, the front, back and slot for disconnector are polished and, at assembly, the corner and top of the sear nose are very carefully honed to give additional smoothness to pull. The full-cock notch of the hammer is jig filed "dead smooth" and the proper depth for the required trigger pull, after which the circular section of the sides—as well as the lower outline including the half-cock notch—are hand-polished and the hole for the hammer pin is burnished. At assembly the full-cock notch is honed to give an extremely smooth surface across which the nose of the sear swings. The weight of trigger pull can be changed by adjusting the angle of the full-cock notch on the hammer. The disconnector is jig-filed on the top of the ears on either side to give the exact clearance necessary to swing under the lower end of the sear when the slide recoils, thus disconnecting the sear and trigger to prevent more than one discharge of the arm per pull of trigger. The top angles, sides, front and angle on back for the sear spring are polished by hand. The top, bottom, sides and the angular surface on the rear end of the trigger are hand-polished, special attention being given to the angular surface at the rear. This is the portion of the trigger coming in contact with the lower front face of the disconnector which in turn is pushed down across this surface by the slide and returned to position (with slide closed) by the sear spring. The sear spring is triple-action in that the left leg acts as a sear spring proper, the center leg as a disconnector spring and the right leg as a grip-safety spring. These legs are hand-polished on both sides as well as at the lower part. The surface of the main spring housing coming in contact with the sear spring is hand polished. The inside surface of the grip safety, on which the right leg of the sear spring operates, is also hand polished, adding to smoothness of operation.

The accompany illustrations of targets demonstrate the shooting ability of the Ace. The target shown in Fig. 7

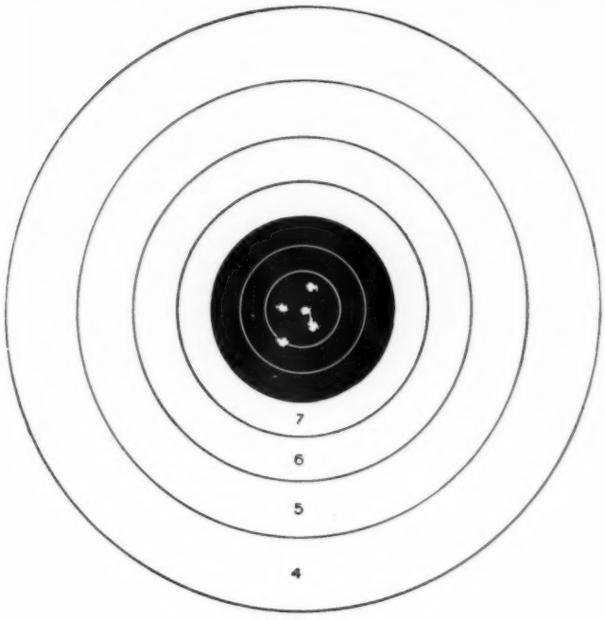

Fig. 7.

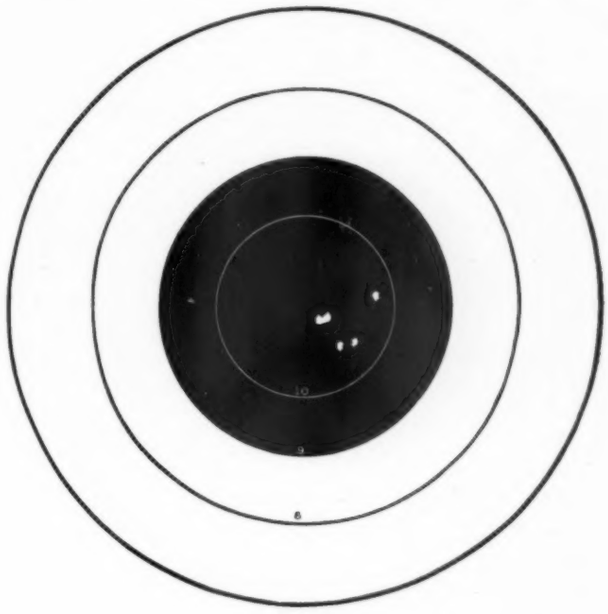

Fig. 8.

was shot at 20 yards using an arm rest and reveals a group of .900-inch. The target shown in Fig. 8 was shot at 25 yards using an arm rest with a group of 1.125 inches; while the target shown in Fig. 9 was shot at 50 yards using an arm rest with a group of 1.940 inches.

These targets were made with standard ammunition. Tests at the factory have shown excellent results using Palma Hi-Speed, Lubricated Kleanbore and Silvadry cartridges. After extensive tests it was found that some makes of cartridges loaded with smokeless powder do not operate the pistol as well as others. This is due to the variations of the powder and is a condition which can and undoubtedly will be improved by the makers of the ammunition.

In the targeting of Colt arms the so-called standard hold is used, namely, the top of front and rear sights are squared on the bottom of black, or 6 o'clock. In Fig. 7 is shown a perfect score shot on the standard 20-yard target using the hold as described. This target shows a very good score but not an exceptional group as one shot was a trifle low. A marksman, no matter how careful, cannot hold the same for each shot.

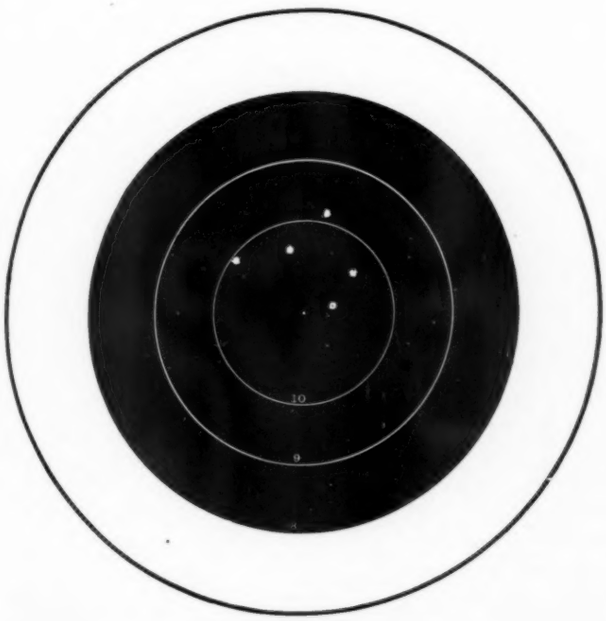

Fig. 9.

The target shown in Fig. 8 shows a very good group at 25 yards, the group slightly to the right of the center, the height being correct for the standard hold.

The target shown in Fig. 9 shows a very good group but not exceptional. It also shows the arm as shooting the least bit high either because the shooter held slightly into the black or because he did not have the rear sight adjusted perfectly. At 6 o'clock hold at 50 yards should not show a hole in the target above the top of the 10 ring. In preparing these targets our aim was rather merely to group the shots than to try for high scores. Consequently we concentrated on the point of aim and the proper alignment of the sights, regardless of the point of impact, after having the sights adjusted on another target.

The shooter who finds himself shooting high or low with this pistol at any distance, or who desires to shoot by taking a full sight or by cutting his sight, may do so conveniently by adjusting the rear sight to suit. In adjusting this sight for elevation the screw on the right side of the top is for elevating or depressing the rear sight leaf. It also acts as a lock for the leaf and is slotted through the lower end and is adjusted for tension before and after hardening. The screw on the left side of the top binds the rear sight base in the position desired, the base being adjusted by the screw under the base, and on the right side. This sight is constructed to allow 1/10-inch vertical adjustment and is graduated for 1/20-inch windage adjustment, but is subject to a considerably greater adjustment if desired.

This new arm makes available to the many users of the Colt Government model caliber .45 automatic pistol and of the caliber super .38 an instrument of precision for target practice having the same essential characteristics of these arms but with the added attraction of lower priced ammunition.

Labor and the National Defense

The Basic Facts of a Much Debated Problem

By C. B. Ross*

THERE probably is no subject about which more ill considered nonsense has been written and spoken than about labor in its relation to national defense. Theories without number have been propounded and they have ranged all the way from considering the subject of transcendent importance, as when we were told that rivets would win the war, to considering it of no importance whatever.

Countless nostrums and panaceas have been proposed as a solution to the problem, frequently by those who claimed there was no problem. Some of these may have been theoretically sound, though nobody yet has been able to devise a method whereby theory could be transformed into practice. Some of them did not even possess the merit of sound theory. Some of them assumed that the Government during war must take the same attitude toward labor that industry takes, entirely overlooking the fact that industry as a whole has no one specific attitude in the matter. Others assumed that a distinctly military organization should be built up in industry for producing the Army's requirements. These overlooked the fact that there then would be existing side by side two entirely different methods of industrial operation and at the same time suggested no machinery whereby the militarized branch was to function.

In this paper I shall try to avoid theories and panaceas and lay a foundation of basic facts. On consideration of these it should be possible to develop a workable plan that will fit in with the other elements of industrial planning now being developed by the Office of the Assistant Secretary of War.

LIVING beings in order that they may sustain life and pursue their efforts must have three elemental and unrelated things—air, water and food. True there are other things, such as clothing and housing, that may be desirable, but human beings can live without any of them. In fact, certain savages do exactly that. However, neither savage nor civilized man can live without air, water and food. Nobody can say that any one of the three is of greater or less importance than the others.

Industry in order that it may sustain life and pursue its ends needs similarly raw materials and labor. So far as modern industry is concerned, power must be added to these two, because modern conditions call for supplies the manufacture of which at a sufficient rate of speed is not possible with manual labor alone. It might be suggested that facilities also should be added to the list, but the facilities of one industry are the finished product of another. It may be stated then that raw materials, labor and power are essential to industry in exactly the same sense that air, water and food are essential to life and nobody can say that one is more or less important than the others.

The functions of the Planning Branch, Office of the Assistant Secretary of War, are to plan for the procurement of all the supplies needed directly or indirectly by the Army in a national emergency. Before its task is completed it will have to plan for the procurement of these three elements which are put together step by step to form the finished item.

As a preliminary to any procurement planning, we must know four things:

First: What we want;
Second: How much of it we want;
Third: When we want it;
Fourth: Where we want it.

Only after these factors are definitely known can we start to plan how we are to get what we want in proper amounts when and where it is needed.

When we have advanced this far we can determine the quantity of the various raw materials that enter into the manufacture of any item. Then we plan how we are to obtain these raw materials or devise and plan to procure acceptable substitutes for them.

So far we have been dealing with inert things. So far as the raw materials themselves are concerned, they can be laid down anywhere where facilities for manufacture are available. The only limitation on this will be the availability of transportation to haul the raw materials there and the finished products away. If we learn that the procurement of raw materials in sufficient amounts within the time limit is impossible, we have recourse to the accumulation of a war reserve of these raw materials.

When it comes to the question of power other complications enter. In many cases, as with steam and hydraulically operated plants, the power must be applied virtually at the point of origin, where elaborate machinery is erected for its manufacture. Electric power, of course, gives a much wider choice of location, but there still remain many problems connected with the distribution of the war load. There are to be considered also many problems connected with the creation of a power war reserve, which may or may not consist largely of obsolete or obsolescent plants.

Power, however, while not inert, is still an inanimate thing and is subject to the absolute domination of man. Given time for the process, it can be created at will and, once created, it will obey the will of its creator within its limitations. Given the knowledge of our power requirements and the time and funds required, the power will be available and ready to do our bidding.

LABOR in its broadest sense covers all human endeavor and in industry it includes both management and manual labor. It is accepted, however, that management in industry needs no war planning. True, during the period of change over from accustomed to unaccustomed tasks, there will be many cases where management will not function with its normal efficiency, but it will function and in a comparatively short time it will adjust itself to its new duties. If it cannot do this industry will fail in its task

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and there is no war planning that the War Department can undertake which will prevent this failure. However, the possibility of such a failure is too remote to be considered.

We have to consider in our war planning then only manual labor, the skilled, the semiskilled and the unskilled workers who are to produce the finished items and their component parts which are required by the Army. The primary study of this subject differs in no respect from the similar study of either raw materials or power. We must know what and how much of it we want and where and when we want it. However, from this point on a new problem enters, because we now are dealing with human beings with human thoughts and human emotions and these must be given careful consideration when we plan how best to utilize the labor that is available. Old adages may be tiresome, but sometimes they are true. "You can lead a horse to water, but you can't make him drink."

Power requirements can be determined fairly closely, though with no such close approximation to accuracy as is possible in the case of raw materials. The calculation of labor requirements is necessarily still less accurate. In the vast majority of cases it can be no more than an intelligent estimate based on a past experience which, in view of the constant change and improvement in manufacturing processes, is far from being an infallible guide. Frequently it can be no more than a guess.

In the beginning, we must consider that, taking the country as a whole, the supply of unskilled labor is ample. If this should prove to be untrue one of two things will happen, because here there is no possibility of substitutes or a war reserve. Either industry in such case must fail or unskilled labor must be imported from neutral countries. In either case there is no war planning to be done at this time which will help the situation. When we are confronted with that situation, we will find the foreign labor ready to come if the inducements are sufficient and it will come if the transportation is available. Whether or not this condition will obtain will depend entirely on the special situation existing at the time and not a general situation such as our war planning considers.

However, there seems to be no doubt whatever that the total amount of unskilled labor in the United States will be ample. Certainly this was true during the World War. The distribution is another matter. If care is not exercised in the placing of war orders, the labor supply of one district will be overloaded and that of another district underloaded. This happened in numerous instances during the World War. Labor, of course, when it can, goes where the work is, but the migration of labor during war is in itself an evil to be avoided whenever possible. It not only creates transportation and housing problems of its own, but it disturbs the delicate balance of the mercantile system which has been developed for the supply of the population and, hence, further disorganizes transportation.

It is the duty of the Facilities Section of the Planning Branch so to cause the creation of new facilities and of the Allocations Section so to allocate both new and existing facilities as to minimize this migration of labor. They cannot do this unless they know the distribution of labor and industry's requirements of that labor to meet the war condition.

Our only source of information regarding these requirements is industry. Industry itself can make only an estimate, perhaps a guess, but at least it will be an estimate or a guess based on some measure of experience. Certainly, neither the Office of the Assistant Secretary of War nor that of any Army supply service is in a position even to make a guess. To date, we have been unable to get this information from industry in an amount to give it any value whatever. To that extent industry has failed in its share of the task of industrial war planning. There may be sufficient justification for the failure, but the fact remains.

What has been said of unskilled labor applies with nearly equal force to semiskilled labor, which is recruited almost entirely from the more intelligent of the unskilled workers. A distinct advantage appears here in that a much larger proportion of women can be utilized in the performance of the semiskilled than the unskilled tasks, this because the latter ordinarily require greater physical strength. Many of these women will be of those moved by a patriotic impulse who normally are not employed in industry. They form an important labor war reserve, but unfortunately, there are practically no statistics available which show either their total numbers or their distribution. Here again we need to learn from industry the number by sex of these semiskilled workers who will be required and the length of time needed for their training.

Industry claims, and perhaps justly, that in the constant evolution of improved industrial processes, particularly in mass production, it is impossible to state the number of semiskilled and unskilled workers that will be required for the performance of allocated tasks. From the standpoint of absolute accuracy, this unquestionably is true, but at least an estimate can be made and industry alone can make it. Certainly, no conscientious manufacturer in his coöperation in war planning would accept a schedule of production, especially for a noncommercial item, unless there was a clearly formulated plan for his procurement of the necessary raw materials and power and he would expect to state his requirements of these. Yet in the vast majority of cases that same manufacturer will calmly assume that the necessary labor somehow will be available and give it no consideration whatever.

If this be a defect in our planning system as developed to date, and it unquestionably is, the defect becomes much more apparent when skilled labor is considered. This is minimized, of course, in the case of commercial items. In the factories producing these there always are in training, consciously or unconsciously, unskilled and semiskilled workers who in an emergency can be advanced to the skilled positions. True, they will not, in the beginning at least, have the skill of journeymen and they will spoil much work, but they nevertheless will get the work done and, with practice, their skill will increase.

The noncommercial items present a quite different problem. Literally hundreds of classes of skilled workers are required in the fabrication of these. These key men will be required both to instruct and supervise the semiskilled and the unskilled and to perform tasks the proper performance of which requires long training in accurate artisanship. In some industries the absolute choke point in production is the skilled labor required. This is notably true in the manufacture of such optical instruments as range finders and panoramic sights. The problem of optical glass has

been solved, but this is not true of the problem of labor. In the assembling of these instruments the highest mechanical skill is called for. As the peace-time demand for instruments of the kind is limited, the number of qualified workmen is small and these are practically all in the employ of one firm.

THE first step in determining requirements is to learn what we want and here we encounter our first difficulty. There is not in the United States any standard terminology of occupational classifications. Such trade designations as, for example, machinist and boiler maker mean absolutely nothing unless we refer to the locality, and sometimes even the individual plant, where they are used. There is no common language in trade designations even in the Federal Government. In numerous cases the Army uses one designation, the Navy another, the Civil Service Commission a third and the Bureau of the Census uses the designation of the locality, getting its information from the worker himself and making no attempt to reduce this to a common standard.

Just how this condition is to be corrected is difficult to say. Sporadic attempts to that end have been made from time to time, but they have accomplished little. During the World War the United States Employment Service did some work along that line and the Hon. John W. Weeks, while Secretary of War, caused studies to be made. A pamphlet entitled, "Minimum Specifications and Index for Occupational Specialists," was published by the Adjutant General of the Army. These were steps in the right direction, but few subsequent steps have been taken. The American Council on Education has done some work, but has been handicapped both by a lack of funds and the lack of an official status.

At the present time this subject is being studied by the Labor Section of the Office of the Assistant Secretary of War in an attempt to develop job specifications for the skilled trades required in the production of noncommercial items which will be acceptable to all procurement branches. When success in this has been attained, as seems a certainty, the attempt will be made to reconcile these specifications with those of the Navy. There then will be a terminology that will be understandable to the United States Employment Service when it is called upon to function in a national emergency.

There is no question of the difficulty of the task, particularly in view of the constantly changing conditions in industry, which reduce the importance of some occupations, increase that of others and sometimes create entirely new ones.

An interesting example of this is the new trade of "airplane mechanic," who must have an even higher degree of skill than the automobile mechanician of thirty years ago. Should the airplane of the future attain the standardization and popularity of the automobile of today we shall see mass production processes introduced and the consequent disappearance of this type of workman. This doubtless is an extreme case, but it shows the trend and indicates the difficulties attendant upon an attempt to secure a standard terminology.

In what has been said there has been an attempt to indicate some of the difficulties that are being experienced in trying to determine what we want. Obviously, we must know this before we can say how much of it we want and until we know these things I can't see that it is a matter of any particular importance when and where we want it. All we can do is plunge ahead and hope for the best, but that hardly can be termed planning. Rather, it is merely hoping there is a Santa Claus.

One thing we know definitely is that the war reserve required for the proper supply of the Army with some items is neither raw materials nor finished product, but labor. We have found this to be true in the case of range finders and panoramic sights, for example. The speed with which production can be attained is dependent solely on the skilled labor available, as machining processes are not particularly complex.

How are we to build up this labor war reserve for the manufacture of these and other noncommercial items?

It has been proposed that we organize in industry a Workers' Reserve Corps composed of skilled men who in an emergency would leave their normal vocations to work in the arsenals, perhaps spending a fifteen- or thirty-day training period in the arsenals each year. If the arsenals were capable of expansion to a point where they could produce the Army's requirements that probably would be a wise policy. It so happens, however, that in any emergency, for which we would be justified in planning, the supplies needed would be so great in amount the total capacity of the arsenals would have little, if any, effect on the situation. From a practical, manufacturing standpoint, they might as well go out of business the minute the requirements curve makes its upward jump.

It strikes me that that recommendation points exactly one hundred and eighty degrees from the true direction. As I see it, our arsenals in peace time should operate on a full-time basis with a full complement of the best workmen obtainable. These men should get the most varied possible training and economy in production should be sacrificed to that end. Then, should the emergency come, we would have available a corps of experts who could be scattered through industry as foremen, inspectors and instructors. In short, my personal belief is that our arsenals should be regarded as training schools rather than as manufacturing establishments. If, together with this, there were carried forward in the arsenals a systematic plan of developing the best possible mass production methods for every noncommercial item on the essential items list we could build up a labor war reserve that would be worth while.

IN what has gone before I have touched on merely what might be termed the technical features of industrial planning. In such planning we try so to arrange matters that when the emergency comes the labor needed for production will be available in the places and at the times when it is needed. The principles involved do not differ materially from those involved in planning for the procurement of power and raw materials. From this point on, however, in the utilization of that which we have made available, there enters an entirely new factor, the psychological. Inanimate things will do our bidding without question. Human beings may do so or they may not.

Labor must perform its task if the war is to be prosecuted to a successful conclusion. Either it must do this through

voluntary effort, the normal method of industry, or it must do it through some form of compulsion and military control. In either case, it must do it in the face of the efforts of unpatriotic agitators who will be "boring from within."

One of the most popular forms of compulsion that has been suggested as a panacea is the so-called "drafting" of labor. That has a plausible sound, as the apparent result would be to place the men who fight and the men who do not fight on an equality, at least so far as the expenditure of effort and compensation are concerned. But let us look at some of the consequences.

In the beginning, the object of a war, as I see it, is to restore the condition of peace at the earliest possible moment in order that the citizens of the country may return to their normal lives and enjoyment of the blessings that our government confers. It seems entirely clear to me that the object will be defeated, as thoroughly as by losing the war, if we ourselves destroy in the attempt to preserve it the very thing we are trying to preserve. Suicide causes as complete a death as murder.

There is no question of the right of any government, our own included, to draft every man, woman and child into its service in the event of war. The only question is regarding the wisdom of such a policy. On the other hand, our Constitution, not only fails to authorize, but specifically prohibits the drafting of any person into the service of any private enterprise in either war or peace. Therefore, the only way the draft of labor could be accomplished would be for the Federal Government to take over all industry, militarize the labor and tell it to go to work. If labor refused it would be necessary to assign armed forces to the task of compulsion.

How much work would be accomplished by such means and how long a revolution would be deferred if they were adopted are matters about which one guess is good as another, but, assuming for the moment that the system would work, what would be the result at the end of the war? Such a condition as described would be socialism in its most extreme form. How would we go to work to unscramble the eggs and return to a normal existence when the time to do so arrived? We can still remember the return of the railroads and the discussion of the Plumb Plan nostrum at the close of the World War!

My personal opinion is that it would not work, and this for a number of reasons. One of them is that such a system would fall of its own weight. In the first place, it would require an enormously complex machine for its operation. Nobody has suggested how these drafted workers are to be housed, fed, clothed, given medical care, promoted or disciplined. And even this takes no account of their families for whom similar provision must be made.

Another disadvantage that occurs to me is that the Government, and particularly the War and Navy Departments, would be sufficiently busy trying to solve the problems connected with winning the war without having all the problems of industry to solve in addition.

An alternative method to this has been suggested. This is that we draft only the workers of military age and put them at work in the factories and on the farms. That would bring two classes of workers side by side, each with different rights, privileges and responsibilities. It is difficult to see how these could be equalized, however conscientious might be the effort to accomplish this. Little imagination is required to foresee the great chaos that would result.

Someone has suggested that the best solution would be to declare all industries, other than those directly connected with winning the war, nonessential. This would throw an enormous number of men out of work and establish bread lines, with the result that the men would be glad to work for whatever they could get. I don't think that calls for much comment, except to invite attention to the fact that no Government agency during the World War had the temerity to declare any industry nonessential. The nearest approach to this was to declare certain occupations nonessential in the so-called "work or fight" order, but even these were few in number. What was done was to declare certain industries essential and, in the event of conflict, give them the preference through priorities.

THE problem, as I see it, resolves itself into this. Should another national emergency confront us, the primary function of the War Department will be to win the war. That should be its only function. We are not going into war unless the people of the country demand it and, once in, we are not going to fight on till we have won unless the people of the country demand that also. No task should be given the War Department which will tend to divert it in the slightest degree from its primary mission and no task should be given it which will tend to arouse any antagonism in the people against the war-making agency. The overwhelming majority of our people is composed of those directly connected with industry and agriculture and those dependent on them. The War Department in war should have no task assigned to it which will bring it into conflict with these elements, either the management or the labor. These are tasks which should be performed by some other agency of the Government.

Returning to that adage which I cited in the beginning, I believe the interests of the War Department and of the United States will be best served if we follow with only slight deviation the industrial methods of peace. Through many years of experience these methods have been evolved as those best suited to industry's needs. With these methods there should be no interference by the Government unless the success of the armed forces demands such interference.

While in the ordinary case occupational deferment under the draft law will not be necessary, nevertheless the law should provide for this so that it may be invoked if necessary. Further, the law should provide for the furloughing back to industry in extreme cases of men who have been enlisted or drafted.

If military necessity should demand governmental interference in labor matters, then the administration of these, except of those arising between the War Department and its own employees, should be placed in the hands of an agency, such as a War Labor Administration, or other similar body entirely separate from the War Department.

INDEX TO ARMY ORDNANCE, VOLUME XI.

An index (alphabetically by subject and author) to ARMY ORDNANCE, *Vol. XI, which is concluded with this issue, will be available shortly and may be obtained upon request addressed to the Editorial Offices, Army Ordnance Association, The Mills Bldg., Washington, D. C.*

ARMY ORDNANCE

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MAY - JUNE, 1931

Month by Month

THE Ordnance Advisory Committee, Society of Automotive Engineers, now in its twelfth year of active participation and assistance in the solution of national defense problems, held its twenty-fourth meeting at Fort Eustis, Va., and Washington, D. C., April 27 and 28. Coming at a time when mechanization is one of the leading topics in military and industrial development, the deliberations of this important group are of especial value. In the opinion of Colonel Masury, Chairman of the Committee, the spring meeting of 1931 was the most successful since the formation of that body in 1920.

Military Mechanization and Industry

The Committee was given an opportunity to witness the operation of the Army's Mechanized Force at Fort Eustis, Va.; while current problems and plans of the Ordnance Department were placed before it for study and advice during the Washington sessions. All in all, the sessions were exactly what such gatherings are intended to be—a meeting ground for a better understanding of the industrial applications of the automotive industry to the needs of ordnance automotive equipment. Congratulations and thanks are in order to the members of the Committee and to the Army Officers who are coöperating with it. The guidance of military development along well organized lines of mutual progress can only mean a better equipped Army. When the committee chairman emphasized the crying need for more up-to-date vehicles of commercial types, as he did in an address at a dinner sponsored by the Army Ordnance Association which brought the meeting to a close, he referred to a subject which calls for speedy remedy. Certain branches of the Army are forced to the expedient of rebuilding old worn-out vehicles of World War vintage rather than spending funds for new equipment. The day came long since when most of the Army's commercial automotive vehicles should have been scrapped. Let us hope that a program of speedy replacement will be authorized without delay.

Aside from emphasizing this pressing need, the concluding session of the meeting was marked by two very important statements. The first was by Maj. Gen. Geo. VanHorn Moseley, Deputy Chief of Staff, who indicated that the future of mechanization for the Army lies rather along lines of an auxiliary to the established functions of the combat units rather than as a separate entity for battle maneuver.

The place of civilian automotive industry in the scheme of things military was clearly established by Maj. Gen. Samuel Hof, Chief of Ordnance, who said in part:

"Past experience has shown that, when other things are equal, the nation which can to the greatest extent bring to the field of battle implements which embody in a practical way the most advanced accomplishments in science and engineering has an outstanding advantage over its opponents. The art and science of war has in the past, in general, been based largely on the experience of the most recent wars. Too often there has been a failure to take cognizance of the possibilities afforded by new inventions and scientific developments.

"One of the greatest of the responsibilities which devolves upon those charged with national defense is, therefore, to consider new developments and inventions in the light of their application to equipment which is essentially military with a view to adopting, in so far as practicable, those developments which will make for its increased efficiency. We should moreover for obvious reasons endeavor wherever possible to use the developments in their commercial form, and in those cases in which material is not produced commercially it is necessary to see that the special equipment which the Army requires shall embody the principles and developments of science and engineering which are best suited to meet its military characteristics.

"Past failures in this respect may be ascribed to too much detachment of military men from the engineers and manufacturers of the commercial world. It has, therefore, been our aim in recent years to avoid this by seeking the closest coöperation and advice of those best qualified to aid us in our problems. Our appeal has been met with a most patriotic and generous support on the part of engineering societies and industry. In the all important field of automotive engineering, we are meeting here tonight with the S. A. E. Ordnance Advisory Committee, this meeting being the 24th since the Committee was organized 12 years ago.

"The members of this Committee, which is composed of the outstanding engineers in this field of industry, I think know how much we value their advice and constructive aid in our problems during these years, but I cannot let this occasion pass without again thanking them for their unselfish and highly valued contribution to the problem of national defense.

"The rapid strides which science and engineering are now making in every field of endeavor, coupled with the fact that the demand for reliability of equipment, increased tactical and strategic mobility of vehicles is greater than ever, render this work of ever increasing importance. You have seen at Fort Eustis armored cars, tanks, tractors, self-propelled mounts, transport vehicles of various types which are being considered in the solution of our problems, and at this particular period when thoughts are not definitely crystalized in all cases as regards types of vehicles, you can well realize how greatly we require your continued assistance."

To the members of the committee, civilian and military, congratulations and thanks for a real contribution to the national defense! Their work is of growing importance.

THE woozlefinch, the fictitious specimen which is neither flesh, fish nor fowl, was the insignia adopted by the American Railway Artillery Reserve in command of the 14-inch Navy guns on railway mounts which participated in the engagements on every famous battlefield of the World War from the middle of August, 1918, to the Armistice. In comparison with the military equipment of this nature of today, the woozlefinch was the forerunners of our present mammoth 14-inch mounts.

Moving A Fortress On Wheels

The strategic importance of the 14-inch gun on railway mount was clearly emphasized some years ago when a weapon of this caliber was transported from the Atlantic Coast to the Pacific using standard railway equipment on standard gage trackage. The tactical value of these huge pieces was more recently established when, on April 8, 1931, one of the two 14-inch guns on railway mounts, part of the defenses of the Panama Canal, made the journey over the Panama Railroad from the Pacific to the Atlantic defenses in seven hours and fifteen minutes. This was the first test of the mobility of the piece in the Canal Zone and of the practicability of transfer between the canal terminals in time of war. Obviously the time consumed in making the journey is not a record as no attempt was made to give the gun and its train the right of way.

The military forces in the Canal Zone, shortly before the movement of the railway mount, successfully transported a battery of 75-mm. field guns by airplane. This together with the latest feat of the railway mount again brings to mind the essential requirement for speed in transportation of military equipment. It appears that the railway guns, whether their movement be from the Atlantic to the Pacific across the broad expanse of the continental United States or the thin strip of the Panama Canal, have the strategic value their designers place upon them. The original woozlefinch was subject to call where most needed at any time and at any point along the front in France and responded promptly; its more modern successor can do likewise.

ARMY Day 1931 again served the very necessary purpose of focusing the attention of the country on the need for adequate preparedness. In that it reminds a rising generation of the responsibilities of national defense it has come to be a day of dedication to the principles on which the stability of our country rests.

A Day of Dedication

Brig. Gen. John Ross Delafield, Counsel of the Army Ordnance Association and President of the Military Order of the World War, in an address incident to the nation-wide observance of Army Day, succinctly stated the case for the proponents of national defense. He said, "The lesson of the ages is that wars cannot be always prevented and that there are but two ways that are most effective in preventing wars.

"The first is by establishing a great super-government, so strong that the nations under it cannot fight amongst themselves. So the Federal Government of the United States has almost entirely prevented war between the States. But this is not now practical for the great nations of the world, for they will not consent to have a great super-government over them. The *pax Romana* of the Ancients is not a practical solution today.

"The second way to prevent wars is for the people of each country to be strong and ready to strike back if they are attacked. People who are prepared and armed are much more safe from attack than are the unarmed and unprepared. This has proven by long experience to be the most effective safeguard now practicable."

The sponsors of Army Day have adopted a very worth while medium in dedicating the anniversary of our entrance into the World War to the high purpose of calling to mind the necessity for adequate national defense and the methods by which it is best attained.

THE Ordnance Department of the Army has announced courses of training for Ordnance reserve officers for the coming summer which reflect the experience of many years of experiment. In the prospectus giving a bird's-eye view of the courses during the current year all the principal phases of ordnance activity are included. These embrace the general subjects of the usual basic courses and specialized subjects of small arms and small arms ammunition, artillery ammunition and bombs, mobile artillery, cannon, fire-control instruments, automotive matériel, metallurgy, inspection, contracts, loading plants and field service.

Reserve Corps Training

This all-inclusive curriculum will be taught at the appropriate establishments of the Ordnance Department, in the Office of the Assistant Secretary of War and at the summer courses for reserve officers at Stanford University, Massachusetts Institute of Technology and University of Michigan. An opportunity is offered Ordnance reserve officers to prepare themselves on the subjects best fitted to their assignments and it is hoped that the number of applicants for the coming year will warrant the belief that the Ordnance Reserve is in the healthy and robust condition the needs of our defense system demand of it.

THIS year marks the fiftieth anniversary of the death of Gen. Emory Upton, author of "The Military Policy of the United States" and an outstanding figure of the American Civil War. General Upton's book had a much greater effect on the history of our country than is generally accredited to it. His carefully collected and authentic records of the wastage in life and treasure had for its thesis the devastating effect of civilian interference in the Army. This he applies to the conduct of the American Revolutionary War as well as the War of 1812, the Mexican War and the War Between the States. In his treatise may be the seed from which has grown our present commendable system wherein civilian interference gives place to civilian coöperation.

Upton's Contribution To National Defense

Few will doubt the wisdom of Upton's theory that "military men must run military affairs." Our conduct of the World War was ample proof of this. At the same time even General Upton, were he alive today, would concede the changing needs of national defense, and while still holding to his announced policy would urge coöperation.

The Need for Plain Talk About National Defense

An Editorial

ON reading elsewhere in this issue the first portion of Mr. Baruch's definitive statement before the War Policies Commission, we are impressed by the comprehensiveness of his detailed analysis. The Commission has the task of weighing the merit inherent in his and other proposals and of recommending to the Congress the most practicable solution of this grave problem. Other testimony to be presented by authorities on the subject and solutions already proposed by others are worthy of the best thought of the Commission, the Congress and our people as a whole. It is not our purpose here to suggest the infallibility of any one proposal. The Commission will weigh the evidence and carry out its legal mandate.

There is, however, in Mr. Baruch's presentation at least one significant statement which demands plain talk. We refer to that part wherein he mentions the seeming general apathy on the part of the American people as a whole "to talk about—much less to provide for" the methods and principles by which war of the future shall be waged. He says (italics ours), "War on this vast modern scale has hitherto so violently disturbed the pattern of the normal economic structure of belligerent nations that, regardless of the side with which rests military victory, the aftermath of struggle prostrates both the conqueror and the conquered. With these most serious considerations you must deal. They depend on *principles which we seem loath even to talk about—much less to provide for.* These principles, while generally conceded in a vague, uncomprehending way, are hardly understood at all. Yet they are of such sinister and overwhelming importance that the neglect of them is, in my opinion at least, one of the most threatening aspects of our governmental policy." We might venture the further suggestion that this loathsomeness of talking about the economic principles of war is but the outgrowth of the deeper taciturnity on the subject of war itself, a state of mind, commendable of course, but foolhardy when it anathematizes all thought of possibilities and probabilities and absurd when it brands him who speaks openly of the subject as a militarist or war-lord. Our national outlook has dwindled to the point where frank speech by the preparedness advocate in many localities is not only loathsome but is cause for sinister suspicion—as though clinical discussion of disease were a culture for the germ, or experiment of the fire underwriter were fuel for the flame. The absurdity of the situation is no less striking than the truth and wisdom of Mr. Baruch's indictment.

THERE seems to be a curious mental aberration abroad in the land that to talk about war and how best to wage it is to bow to the yoke of the swashbuckler and the fire-eater. The very word is *passe* among many who have been led to believe that peace need never again be restored by the arbitrament of arms. These myopic brethren would scuttle our ships (few as they are) scrap our weapons (scant though they be), drive military training from our schools (limited as it is), whittle our skeleton nucleus of professional defense insurance agents (some 137,000 known as the Army and some 108,000 known as the Navy and Marine Corps) and leave us to look to the God of Hosts for protection from the greed and aggrandizement of our fellow men! Little wonder that he who talks of the more fundamental needs of national defense—the equitable and efficient controls of men and things for the common good—is heeded by but a fraction of our one hundred twenty millions!

We should say that the condition which justifies Mr. Baruch's statement arises out of the contrast between the fair methods of those who believe in adequate national defense and the insidious activities of those who do not. The fact is that the "militant pacifist" has the effrontery to ply his trade in season and out of season, and a supine public is made to swallow his prattle the meantime that same public's faith in its national institutions is unconsciously weakened. Witness the spectacle of Prof. Albert Einstein, recently a feted visitor to these shores. Conceding that a sparse dozen of the physicists of the world can comprehend his theories, and by that token award him just claim to the title of the Newton of our day. We accept without murmur his attack on our American system of defense when he urges pacifist groups in New York and Chicago to refuse to bear arms and to campaign openly against the system upon which the permanancy of our national life is founded. It is not in point to say that relativity is one thing and national defense another and that the expert in the one can easily be the ignoramous in the other. It is in point, however, to observe that pacifistic blurb is served up daily and in such quantity that it saps at the very roots of our national outlook and adds to the loathsomeness in which the national defense advocate is held.

WE wish that the distinguished war-time chairman of the War Industries Board had elaborated more on this phase of his discussion. We wish that millions of others might voice similar feelings and drown out in major tones the minors that make discordant our otherwise harmonious hymn of peace through protection. Not all of us are called upon to lead in the cause of national defense but each of us has the very definite duty to maintain the institutions upon which our Nation rests. The common defense, if our history is more than a jumble of distorted phrases, is the one pillar upholding the structure when all peaceful props have failed. This is as true today as at any time since the Continental Congress. And knowing that, as the great majority of us do, we are loathe to talk when words are mostly needed and action is not required. It is high time that we shake the sleep from our eyes, stifle the yawn and speak out. Else others who are now acting and who talk most when there are fertile fields to till will not pass the opportunity by. He who sponsors national defense in its every ramification—social, economic, industrial and strategic—can carry his head high and "talk about it." In his own soul he knows that he seeks not war but peace—a peace which comes quickest and remains longest with the country which studies and prepares for the remedies of war, should it ever come, and is not loath to talk frankly and freely about them.

Professional Notes

The New Chemical Laboratories of Picatinny Arsenal

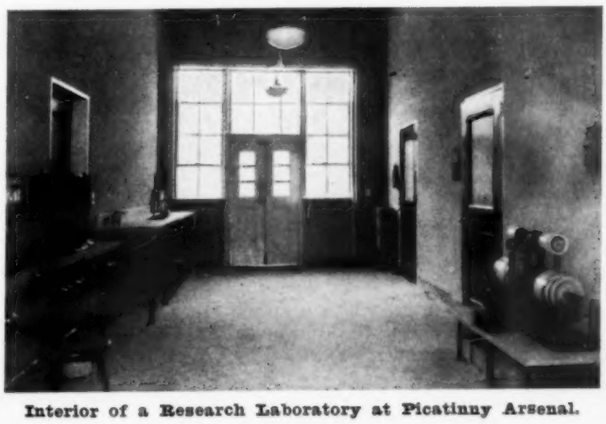
IN JULY, 1926, the Lake Denmark (near Dover, New Jersey) Naval Storage Depot explosion caused the complete destruction, by collapse and fire, of the chemical laboratory of the Picatinny Arsenal, which is located in the immediate vicinity. Funds for the rehabilitation of the arsenal were appropriated by Congress in 1928, and the new laboratories provided for have been completed and are now occupied.

The Main, the Organic Research and the Initiator Research Laboratories at Picatinny Arsenal.

As some of the investigations and tests carried out by the chemical staff are in connection with explosives and ammunition, the element of hazard was minimized by the segregation of this type of work in separate buildings. On this basis, the offices, library, photographic studio, and laboratories for nonhazardous work are contained in one large building. Each of the more hazardous types of work is carried out in a special building.

The new buildings are constructed of brick, with facings of Indiana limestone. Every effort has been made to render each structure fireproof, metal window frames and sashes, mastic and terrazzo floors, and metal laboratory furniture being used throughout. The work desks and benches are topped with Alberene stone. Hoods are constructed of Alberene stone, Monel-metal and glass. Each hood is divided into two 3-foot compartments having a glass-windowed back, and is placed in front of a window to make extensive use of adequate lighting. A Monel-metal steam bath occupies one compartment of each hood, in all the new installations, the top of the bath being level with the floor of the compartment.

The largest building of the new group occupies 112 by 42 feet and has two floors and a semibasement. On the first floor are the administrative offices, the technical library of the arsenal and the analytical laboratories. The second floor is occupied by the physical chemistry, colloid chemistry and calorimetric laboratories, the photographic studio and a lecture room. In the basement are located the metal testing laboratory, main stock room, constant temperature room, laboratory for physical tests, sampling room and locker room. The next largest building measures 65 by 38 feet and consists of one floor and a semibasement. On the first floor are an office and seven laboratories for research work in organic chemistry, chiefly relating to high explosives, cellulose and nitrocellulose. The basement is occupied by low-temperature nitration, optico-chemical, organic combustion, and powder process laboratories, as well as a stock room.



Interior of a Research Laboratory at Picatinny Arsenal.

A one-story building, 34 by 31 feet, is devoted to research work on detonating compounds and fuze powders. It contains an office, chemical laboratory, physical testing laboratory, and three small rooms for mixing, pressing and testing. Another one-story building houses the laboratories in which research investigations in the fields of pyrotechnics and physics are carried out.

The stability tests and experimental work, sensitiveness to outside influences of the tests rather than because of any hazard involved, are conducted in a one-story building, 34 by 23 feet.

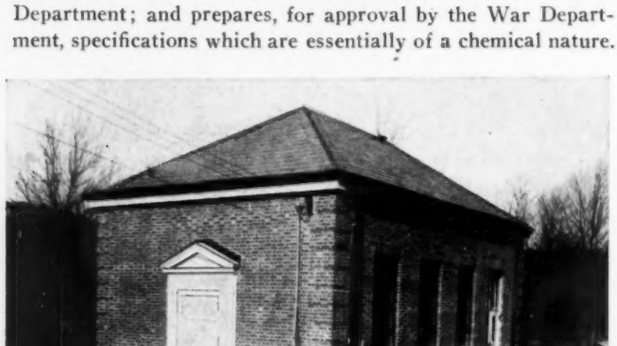
In addition to the laboratory buildings listed above, small, semipermanent structures are used for film and solvent storages, five sample houses serve for overnight and temporary storage of explosives used in the laboratories, two buildings of twenty rooms each, are required for the storage of master samples of smokeless powders, and five buildings containing thirty-six compartments are used for experimental and surveillance storages at elevated temperatures.

The laboratory organization consists of research, stability and analytical sections, a technical library, and photographic studio. The research section is subdivided into a number of smaller, operating units.

WHEN the large variety of materials and types of chemicals entering into the production and development of ammunition are considered, the scope of the chemical and physical work done in the laboratories is recognized as being necessarily broad. A resumé may be of interest.

The analytical section maintains chemical control of the

experimental propellent, high explosives and loading areas, the plating shop, and the smokeless powder, high explosives, and loading departments of production. In addition to such control, the section makes all chemical and physical specification tests on materials procured for the arsenal's inspection department and other establishments of the Ordnance Department; and prepares, for approval by the War Department, specifications which are essentially of a chemical nature.



The Stability Laboratory at Picatinny Arsenal.

In addition to the explosives used in ammunition, the materials tested by the analytical section include paints, oils, greases, coals, water, metals, textiles, papers, lacquers, cements, pharmaceuticals, solvents, waterproofing compounds, acids, asphalts, waxes, etc. In view of the diversity of the tests, an experienced personnel involving some specialization, but having a certain flexibility, is necessary.

The stability section conducts surveillance tests on all powders and explosives in military service and so represents a surveillance center for the Army as a whole. It also makes stability tests on all experimental powders. In addition to its control functions, it carries out a large number of experimental problems in connection with new and special methods of storage, the relative stabilities of different types of compositions, the relation between temperature and stability, the development of new tests, the relation between ballistic value and chemical stability, etc. As the stability tests employed are very sensitive and the safety regulations governing the storage of powders are strict, specially trained personnel is required for coördination of the work done by this section.

The research section works in the fields of physics, pyrotechnics, physical chemistry, cellulose, nitrocellulose, high explosives, colloid chemistry, detonators, and fuze powders. While there is a certain degree of flexibility in the assignment of problems, most of the senior research men specialize in one field. Much of the work done is of a confidential nature, but sufficient fundamental investigation is carried on to warrant the publication of papers on physical constants, organic syntheses, physical chemistry, colloids, the development of analytical methods, and the application of special chemical compositions in ammunition development and practice.

In view of the increasing necessity for chemical research and control in ammunition development and manufacture, the availability of the carefully planned chemical laboratories now located at Picatinny Arsenal is believed to be of distinct importance in the list of national assets required in time of war, and in the necessary maintenance of a state of efficient preparedness.

Ammunition

BECAUSE of complaints of service users that the authorized saluting charges give objectionable blast effects in built-up areas, action has been taken to reduce the weight of saluting charges to one-pound for the commonly used types. It has also been decided to assemble saluting charges at Ordnance establishments and issue them ready for use so as to eliminate assembly by troops. Supply in this way will be somewhat more expensive because of increased transportation costs. However, the additional expense is justified in as much as a more satisfactory round will result and the number of accidents during assembly by troops will be reduced.

This policy will be put into effect gradually, as stocks of charges already on hand in bags are sufficient for about one year's issues and must be used up first. Meanwhile, a pilot order of 1,000 rounds has been placed at the Picatinny Arsenal to develop a standard practice for the assembly of this ammunition.

Bids were opened recently for the sale of 2,000 tons of sodium nitrate at the Columbus General Ordnance Depot. Award was made to the Hercules Powder Company at an average price of $31 per ton. The sale was a further disposal of sodium nitrate at this depot to relieve pressure against the walls of the warehouses.

During the coming summer, the 14-day methyl violet paper tests of powder charges and bulk powder will be repeated. By this test, deteriorating powder is promptly identified. In the last test conducted in the summer of 1930 on powder of web thicknesses up to, but not including, the 8-inch gun, a considerable quantity of powder was classified as of questionable stability and exchanged for new FNH powder. This test was carried on not only in storage depots, but in several corps areas as well. The 1931 tests will include tests of stocks of bulk powder and charges in corps areas, stocks in the overseas departments, and stocks in the hands of the Ordnance Department. The 14-day test will be followed by a 2-day test on doubtful lots pending the accumulation of data as to the significance of the paper test as compared with the 65.5° C. surveillance test. The evidence seems to indicate that the 14-day test detects deterioration long before the powder becomes a storage hazard and reveals the lots which must be closely watched in surveillance tests until finally withdrawn as unserviceable.

Small Arms

THREE years ago the Adjutant General of the Army approved the proposed modification of the U. S. Rifle, caliber .30, model 1903, consisting of the substitution of a pistol grip stock for the present stock. The new stock is of the model

Interior of an Organic Chemical Research Laboratory at Picatinny Arsenal.

known as Type C modified. These are approved for future manufacture and issue, after depletion of the present stocks of the current type.

Due to the large quantity of the present type stocks on hand, it is expected that a considerable period of time will elapse before the pistol grip stock is manufactured for issue.

Two caliber .276 U. S. semiautomatic rifles (Pedersen design) have been received from the contractor and are now being studied by engineers of the Ordnance Department. A sample U. S. semiautomatic rifle, caliber .276 (Garand) has been undergoing tests at the Aberdeen Proving Ground.

Development work on the solid gilding metal bullet, caliber .50, is being continued and sketches have been made of several other types of solid copper rod bullets with a view to relieving the pressure which has been excessive with earlier types. The copper rod bullets will be made up and tested as soon as practicable.

Frankford Arsenal chromium plated bullet dies and reports that these dies were used for resizing caliber .30 tracer bullets and have been "standing up quite well" and it is believed that an analysis of the costs between such dies and carboloy dies, and any other special alloy dies will show that none of them has given as satisfactory results as the chromium plated dies in cost per thousand of resized bullets.

Command Exercises Essential

MAJ. GEN. HUGH A. DRUM, Inspector General of the Army, in a report to the Secretary of War, asserts that unless efforts are made in the near future to afford opportunities for higher officers to command in field exercises forces of all arms, the Army will revert to the state in which it has found itself at the beginning of every war in which it has been engaged.

The primary mission of the Regular Army, General Drum says, "is to stand ready at any moment to meet any emergency with the greatest possible combat power which its organization and strength may be capable of developing. Unless maintained in such a state, a Regular Army engenders unwarranted reliance on a mythical preparedness and is uneconomical.

"Whether the Regular Army's status of preparedness and training is adequate for the performance of this mission is highly questionable," General Drum says. "The regular combat forces in the overseas possessions may be considered up to standard, except for certain needed modernization of weapons, but there are serious doubts relative to those in the continental garrisons.

"The latter are dangerously weak in strength and in modern weapons and equipment. Scattered in small garrisons along our extensive frontiers and in the central States, no opportunity is afforded for practical training in tactical mobility and maneuvering and tactical fire power of combined arms. Yet these very qualities are the essence of the combat power that a regular army should possess.

"While the personnel of the Regular Army combat forces as a whole is in a high state of efficiency from the viewpoints of theoretical education and individual knowledge of the technique of utilizing their available weapons, there appears to be a serious weakness in the practical tactical and logical handling of troops of all arms and their weapons in combination, under field and combat conditions.

"The junior leaders have too few opportunities to develop in a practical field service sense that resourcefulness, initiative and knowledge of men and of terrain so essential to efficient battlefield leadership. The combatant arms are seldom brought together for combined field exercises. Higher commanders have too few opportunities to exercise vital functions of tactical direction, control and coördination, and to obtain by experience an understanding of the many practical difficulties which inevitably arise in the actual execution of tactical operations by combined arms which cannot be obtained at schools or in staff rides, terrain or command post exercises.

"Officers with World War experience in the direction, control and coördination of units of combined arms are rapidly disappearing from the active list. Unless special efforts are made in the near future to afford opportunities for higher officers to command in field exercises forces of all arms, the Army will again revert to the state in which it has found itself at the commencement of all wars in which it has been engaged, with a serious lack of leaders trained to command larger units and an ignorance on the part of these units of the vital tactical essentials of mobility, maneuverability and fire power of combined arms."

Referring to the large annual turnover of officers on duty with combat units, General Drum said:

"Too large a portion of the short time that officers habitually remain on duty with their combat commands is devoted to administrative duties. The greater part of an officer's service is spent away from troops—at schools, on duty with civilian components and at various administrative headquarters.

"The duties of the Regular Army as a training force for the civilian components and the housekeeping tasks incident to its own living and administration tend, of recent years, to obscure its vital mission, for the successful execution of which a higher state of combat efficiency than now exists is indispensable.

"While some of the defects indicated are subject to administrative correction, real improvement in this connection is dependent upon allotments of adequate funds for combined field training."

Cost of Military Aircraft Reduced

REDUCTION in airplane prices during the year have not benefited military organizations as much as commercial aviation, according to information recently made available.

Better, faster, and improved planes are being secured by the Navy at prices comparable to those formerly paid for planes of lower quality. Actual price reductions, however, are not great enough to make much difference, it was said at the Army Air Corps.

The fact that aircraft for military and naval use must meet far more rigid tests than commercial aviation requires is largely the cause of this condition. Prices actually have gone down on some types of military and naval aircraft, but the cost of other types has risen.

Insistence on a large safety factor is the chief reason for existing differences in cost between commercial and military planes, Maj. Gen. James E. Fechet, Chief of the Army Air Corps, testified before a subcommittee of the House Committee on Appropriations. Construction of planes with sufficient safety factors requires "enormously expensive" work.

Engine prices for Army aircraft have shown a downward trend, but the decrease in this item is comparatively small when contrasted with the total cost of plane and spare parts. The tendency to purchase fewer spare engines for new planes supplements the downward trend in motor costs for naval aircraft, but the total cost of planes is not affected very much because of compensating increases in other items.

Estimated average costs of fighting planes for the next fiscal year are $26,100, according to data made available at the Bureau of Aeronautics. Tables show also that it is estimated observation planes will cost $36,400 each, as contrasted with $41,250 in 1930; that torpedo planes will cost $45,800 each, as contrasted with $72,500 in 1927; that patrol planes will cost $85,000, as contrasted with $105,000 in 1930; that transport and utility planes will cost $75,000, as contrasted with $80,000 in 1930, and that training planes will cost $14,750, as contrasted with $24,000, the amount paid in 1930.

Association Affairs

Washington Post

THE second regular monthly meeting during 1931 of the Washington Post, Army Ordnance Association, was held February 26, 1931, at the Cosmos Club, Washington, D. C. At the invitation of Mr. I. H. Fullmer, Chairman of the local section, American Society of Mechanical Engineers, the Washington Post was invited to attend a dinner and lecture on that date. The principal speaker of the evening was Lt. Col. Hardee Chambliss, Ord. Res., Professor of Chemistry at the Catholic University of America. His subject was Muscle Shoals. Colonel Chambliss, by reason of his important work in the field of chemical engineering and his Army service as plant manager of U. S. Nitrate Plant, No. 1, Sheffield, Ala., is well qualified to discuss the nitrate plants at Muscle Shoals particularly in their relation to the national defense.

Colonel Chambliss was graduated from Virginia Military Institute, received his M. S. degree from Vanderbilt University, and later Ph. D. from Johns Hopkins. He has engaged in an extensive career of teaching at the University of the South, Sewanee, Tenn., Marion Institute, Marion, Ala., and at Columbia University, New York City. He was professor in charge of Department of Chemistry, Oklahoma College and Assistant Commissioner of Health in Oklahoma. He has served as research chemist for the Moore Electric Company, Newark, N. J.; General Chemical Company, New York; chemical director, Commercial Acid Company, St. Louis; and plant manager, U. S. Nitrate Plant No. 1. In the World War he was commissioned major and later lieutenant colonel, Ordnance Department. He had charge of the investigation of nitrogen fixation and was commanding officer of U. S. Nitrate Plant No. 1. He is at present a colonel on the reserve roster of the Ordnance Department and is thoroughly familiar with the Muscle Shoals situation. His address was most interesting to the unusually large number of members present.

THE March meeting of the Washington Post was held March 27th at the Army and Navy Country Club and was in the nature of a joint foreign affairs meeting. The principal speaker was Mr. William L. Cooper, Chief of the Bureau of Foreign and Domestic Commerce, Department of Commerce, formerly commercial attaché, American Embassy, London, who spoke on "Our Business Abroad." Mr. Cooper is well known throughout the United States for his intimate knowledge of our foreign trade activities.

The Washington Post, Society of American Military Engineers, at the invitation of Lieut. Col. Charles G. Mettler, President of the Ordnance Post, participated in the meeting which was preceded by luncheon served in the club dining-room.

Boston Post

COL. FREDERICK H. PAYNE, the Assistant Secretary of War, was the honor guest at a meeting of the Boston Post, Army Ordnance Association, at the University Club, March 2nd. Colonel Payne outlined industrial conditions before the World War and during its early stages. He told how inefficiency was rampant and there was much waste of time and material because the country was not prepared to utilize the factories and industries to the best advantages. "Contracts for some items," he said, "were placed far in excess of requirements, resulting in a waste of materials and manufacturing capacity. All these things had their own effect upon the cost of living and inevitably set in motion a cycle of uncoördinated activity, congestion, rising prices and money inflation.

"We learned by costly experience, and toward the end of the war our industrial effort, under the guidance of able men, was gradually being placed on a sound and efficient basis. These men have pointed out again and again that a similar experience in any future emergency could be avoided only through the preparation in time of peace of a reasonable plan for the employment of our economic resources in war. The development of such a program is 'preparation for industrial mobilization.' The legal responsibility for this preparation is centered in the Assistant Secretary of War.

"The determination of emergency requirements is in itself a difficult problem. Estimates of necessary munitions are based upon the size of the force we would mobilize under the various situations with which we might probably be faced. Since continuous improvement is sought in every weapon and piece of equipment we have, specifications are subject to constant change. With the coöperation of manufacturers these specifications are then critically examined from the standpoint of practicability of production.

"Another consideration of major importance is that of preventing competition among Government purchasing agents. This is accomplished through the specific allocation of existing establishments to appropriate supply bureaus. With certain agreed-upon exceptions, plants allocated to the Navy are not approached by the Army, and within the Army a plant allocated to one supply service is left severely alone by other services. Thus each selected plant is forewarned of the job it will be expected to perform—and upon receipt of proper notification from the Government can undertake the task with the least possible delay. Almost 17,000 factories have so far been allocated to branches and services."

Other speakers and honor guests included Rear Admiral L. M. Nulton, commanding the First Naval District, who spoke briefly of his connection with the Ordnance Department of the Army while serving with the Bureau of Ordnance of the Navy Department. He emphasized the mutual problems of those governmental organizations and spoke particularly of the desire of the Navy Department and of his own personal wish to coöperate with the Army in its industrial war planning.

Dr. Samuel W. Stratton, Chairman of the Board, Massachusetts Institute of Technology, recounted some of the more interesting relations of the Bureau of Standards, of which he was formerly director, with the munitions developments and products for the Ordnance organizations of the Army and the Navy. He described in some detail the coöperation of

the Bureau of Standards in devising a method for spotting impacts in naval target practice.

Maj. Gen. Fox Connor, Commanding General, First Corps Area, discussed the importance of industrial war planning by reference to the handicaps placed on General Pershing when he reached France in 1917. General Connor stressed our failure properly to prepare American industry for the production of munitions prior to our entrance into the war and urged the active coöperation of the military authorities with industry in industrial war planning.

Dr. Karl T. Compton, President of Massachusetts Institute of Technology, discussed the functions of that institution in preparing for another emergency and told several interesting anecdotes connected with his experience during the World War while carrying on research work as physicist in the development of military and naval munitions.

Among the other distinguished guests at the speaker's table were Mr. Howard Coonley, Chief of the Boston Chemical Warfare Service Procurement District; Brig. Gen. Alston Hamilton, commanding the First Coast Artillery District; Brig. Gen. Meriwether L. Walker of the First Corps Area; Capt. C. A. Abele, Chief of Staff of the First Naval District; Col. Edward F. Miller, Aux. Res., Assistant Chief of the Boston District Ordnance Office; Col. Thayles L. Ames, First Corps Area Ordnance Officer; and Col. John H. Hughes, Chief of Staff, First Corps Area.

The meeting was well attended, nearly one hundred members and guests of the Post being present. The organization under the leadership of Colonel Whitelegg, its president who presided, is to be congratulated on this splendid interest.

Necrology

THE Army Ordnance Association announces with regret the death of several of its most active members during the past few months. Col. Michael Friedsam, a member of the Advisory Board of the New York Ordnance District and long active in the business and economic affairs of his city and state, died in New York March 6, 1931. Born in New York City, he was educated in the public schools and at the Weston Military Academy, Weston, Conn. He was associated with B. Altman & Co. during his entire business life, and at the time of his death was president of the Altman Foundation and a director of the Fifth Avenue Association, Merchants Association, Bankers Trust Company, Bank of the Manhattan Company, Franklin Savings Bank and others.

During the World War Colonel Friedsam served as Quartermaster General of the New York National Guard. He was the merchant representative of that state to the Federal Food Administration. In recognition of his life-long interest in French art and for services rendered to the French Government he was made Chevalier of the Legion of Honor.

Because of his interest in national defense and of his commercial and industrial experience he was a valuable adjunct of the New York Ordnance District activities.

Mr. James B. Bonner, a charter member of the Association, the manager of sales of the Philadelphia district for the Carnegie Steel Company and affiliated organizations, died suddenly in Philadelphia April 8th. During the World War he served in Washington as first chairman of the Committee on Steel Distribution of the American Iron and Steel Institute and was highly commended for his important work during that period. His long experience in the steel industry placed him high in the group of experts who were consulted by Government officials both in peace and war. His war service was of great value, notably in the adjustment of contracts looking toward the reduction of competition and confusion in government purchases. His familiarity with this particular field was of material assistance in the control of great volumes of supplies, and it was for this important contribution that he received official commendation.

Mr. Bonner was born in Philadelphia on July 27, 1863, and began his active service with the steel industry in the employ of the Carnegie-Phipps Company, Ltd., and continued with that company and its successors. He was a member of the American Academy of Political and Social Sciences of Philadelphia and of the American Iron and Steel Institute.

The Association extends condolences to the officials of the St. Louis Post and of the St. Louis Ordnance District upon the death of Mr. C. W. Nelson on March 21, 1931. During the World War Mr. Nelson was Assistant District Chief of the St. Louis Ordnance District and later served as Assistant Chief of the Claims Board. He was a charter member of the St. Louis Post, Army Ordnance Association, and took an active part in all activities of the Post from the date of its inauguration to the time of his death. He was indefatigable in his studies and contributions to the industrial mobilization plans of the St. Louis Ordnance District. His loss will be keenly felt in both the district and local post organizations as well as in the national organization.

As the March-April issue of ARMY ORDNANCE went to press, word was received of the death of Mr. Philip P. Quayle, chief physicist of the Peters Cartridge Company, who died suddenly February 21, 1931. A frequent contributor to these pages, Mr. Quayle was well known both in this country and abroad for his contributions to the art of spark photography particularly in its application to the study and development of small arms and small arms ammunition.

Since publication of the last issue of ARMY ORDNANCE notice has also been received of the death of G. F. S. Mann, Brooklyn, N. Y.; H. A. Lewis, Norristown, Pa.; D. E. Felt, Chicago, Ill.; and William G. Clyde, Pittsburgh, Pa. To the relatives and friends of these members the Army Ordnance Association extends condolences.

New Members

THE following were admitted to membership in the Association since the last issue of ARMY ORDNANCE: Robert M. Allman, Atlanta, Ga.; N. D. Atkins, St. Louis, Mo.; E. F. Barnes, St. Louis, Mo.; G. M. Berry, St. Louis, Mo.; D. C. Bowman, St. Louis, Mo.; H. L. Boyle, Chicago, Ill.; Leonard W. Breidenstein, San Francisco, Calif.; Raymond A. Brown, Harrisburg, Pa.; G. R. Burkhardt, Holyoke, Mass.; Arleigh A. Burke, Ann Arbor, Mich.; E. W. Davis, St. Louis, Mo.; W. George Devens, Watertown, Mass.; Joshua B. Dickson, San Luis Obispo, Calif.; George A. Dingee, New Cumberland, Pa.; Clyde T. Erwin, Kings Mills, Ohio; John H. Foster, Baltimore, Md.; Robert F. Gadd, Hartford, Conn.; L. Melvin Gendreau, Westfield, Mass.; Robert S. Geran, Marion, Ohio; Ralph H. Higgins, Chicago, Ill.; James H. Howard, Belmont, Mass.; A. A. Jones, Chicago, Ill.; D. Larkin, Kirkwood, Mo.; E. E. Libmann, Schenectady, N. Y.; Leonard A. McQuown, Punxsutawney, Pa.; Franklin Mitchell, Watertown, Mass.; B. H. Mueller, St. Louis, Mo.; Ralph M. Osborne, Watertown, Mass.; Samuel E. Pearman, Brooklyn, N. Y.; L. A. Pettus, St. Louis, Mo.; Homer A. Plunkard, Detroit, Mich.; Isaac H. Ritchie, Augusta, Ga.; Wilfred W. Russell, Stanford University, Calif.; Fred G. Singer, Paris, France; Frank H. Starr, Seattle, Wash.; Thomas G. Stitt, Allenport, Pa.; R. A. Visco, Woodbridge, N. J.; A. C. Amman von Borowsky, Patterson, N. J.; Charles Weppman, Oak Harbor, Ohio; Seth Wiard, Chicago, Ill.; and Oliver E. Willis, New York, N. Y.

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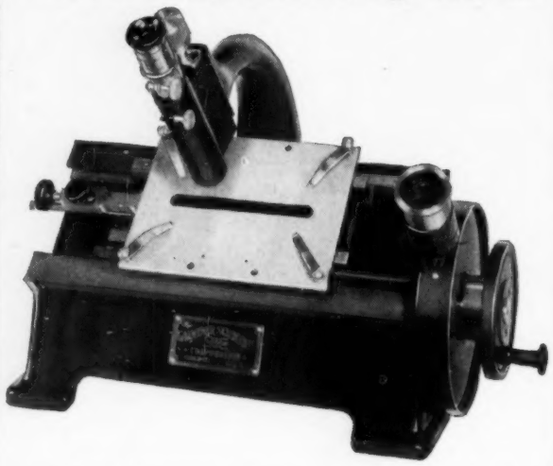

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Digest of Ordnance Patents

THE following digest of recent ordnance patents is by W. N. Roach, Chief, Patent Branch, Office of the Chief of Ordnance. Letters patent have been issued:

To Grover R. Ledford, patent No. 1,783,246 for a shock absorbing structure for firearms which provides a telescoping stock with a resilient element between the members.

To Stanislas Rousseau, assignor to Western Cartridge Company, No. 1,783,261, for a process and apparatus for making bullets and relates to specific forms of dies and punches for forming bullets.

To Giuseppe Mascarucci, assignor to Safat Societa Anonima Fabrica Armi-Torino, No. 1,783,577, for a device for feeding cartridges and for cocking the striker in automatic firearms. The invention relates to a specific form of device for feeding cartridges transversely through the feedway of the firearm.

To Fritz Herlach and Theodor Rakula, assignors to Reinische Metallwaaren-Und Maschinenfabrik, No. 1,784,355 for an automatic firearm with two cartridge magazines. In this device the firearm is provided with two magazine-receiving openings diverging downward from the firearm and with a special stop for holding the cartridges in one magazine while they are being fed from the other.

To Carl A. Larsson, assignor to Vickers-Armstrongs, Limited, No. 1,784,016 for a mounting for automatic guns. This device may be used for either ground guns or for anti-aircraft firing.

To Forrest K. Howard, Office of the Chief of Ordnance, No. 1,786,615, for a combination mount for machine guns. This invention provides a specific adapter for machine gun mounts which permits the dual use of the piece as a ground gun or as an antiaircraft weapon.

To Andy Bochnak, No. 1,787,354, for a repeating rifle. This rifle is provided with a drum-shaped magazine in which the cartridges are carried and which is rotated automatically by the firing mechanism to bring the cartridges successively in front of the firing pin.

To Charles J. Jefferson, assignor to J. Stevens Arms Co., No. 1,787,004, for a locking means for the barrel of a shotgun, the means also serving to guide and support the hammer mechanism.

To Capt. Dudley B. Howard, No. 1,786,614, for a marksmanship training device for firearms. This device consists of a small attachment which may be clamped to the side of the firearm and which may be set to prevent explosion of a cartridge for a predetermined number of attempted firings and then permit explosion thereof.

To Vaclav Holek, assignor to Ceskoslovenska Zbrojovka Akciova Spolecnost V. Brne, No. 1,786,537, for an apparatus for filling magazines for self-loading firearms. The device consists of a series of compartments, arranged side by side, in which cartridges may be loosely placed and a side opening at the bottom of the receptacle to which a cartridge magazine may be attached. A movable member is provided for forcing the lowermost row of cartridges through the side opening and into the magazine.

To Emanuel Holek, assignor to Ceskoslovenska Zbrojovka Akciova Spolencnost V. Brne, No. 1,786,536, for a firing mechanism for automatic firearms. This invention relates to

a special firing mechanism which may be set for automatic or for single-shot firing.

To Robert F. Hudson, assignor to Automatic Guns, Inc., No. 1,786,207, for a machine gun. This is a gas-operated weapon in which a piston is moved forward storing up energy in a resilient element which then acts to operate the gun mechanism.

To Robert S. Ellis, No. 1,787,939, for a double-barrel gun—either barrel of which may be fired as a repeater or the barrels fired successively as desired.

To Francisco Minondo, No. 1,788,246, for a new and improved form of safety device for small arms.

To Benjamin F. Schmidt, assignor to Schmidt Products, Inc., No. 1,788,637, for a shotgun shell. In this invention corrugations are provided toward the base of the shell providing sufficient friction to prevent the shell from sliding out of the gun barrel.

TO Reginald F. Sedgley, No. 1,788,443, for a firearm. The invention covers minor points of novelty in the firing mechanism and in the attachment of the barrel.

To John D. Pedersen, No. 1,789,835, for a gun barrel with fins for air cooling and a specially constructed hand guard embracing the barrel.

To Maj. James L. Hatcher, Ordnance Department, U. S. Army, No. 1,789,308, for an apparatus for rifling gun barrels of particularly hard steel alloy.

To Dr. Samuel G. Green, Office of the Chief of Ordnance, No. 1,790,212, for a gun mount in which the effective base remains substantially the same throughout all elevations of the piece.

To Eugene G. Reising, assignor of one-fourth to Alva C. Washburne, No. 1,790,320, for a firearm. The invention relates to minor details of construction of a firearm.

To Oscar F. Mossberg, assignor to O. F. Mossberg & Sons, Inc., No. 1,790,482, for a specific means for ejecting the cartridge, cocking the firing mechanism and other details of construction of a firearm.

To Christian L. Bloch-Jorgensen, No. 1,794,141, for a cartridge with projectile for smooth-bore firearms. The projectile in this instance has a conical base, or sabot, adapted to hug the bore of the gun to prevent gases escaping beyond the projectile.

To Bishop M. Crawford, No. 1,792,732, for a gunlock. This invention covers a specific form of hammer and sear for use in double-barrel guns in which one barrel is placed above the other.

To John Le B. Arbuckle, assignor of one-third to Harry H. Semmes, No. 1,791,590, for an auxiliary arm. This invention provides means for attaching an annular rifle barrel on the side of the barrel of the shot gun.

To Capt. Thomas M. Jervey, Ordnance Department, U. S. Army, No. 1,790,867, for a magazine for rapid-fire guns. The magazine holds the belt of cartridges for a machine gun and has means for initially feeding the cartridges to the feed mechanism of the gun.

To Clifford A. Woodberry, assignor to E. I. DuPont de Nemours & Company, No. 1,783,372, for a process of making detonators. In this process the detonator is cast by passing the containers loaded with loose granular explosive through a warm chamber, or bath, and then cooling to obtain a cast charge.

To Capt. Charles H. Keck, Ordnance Department, U. S. Army, No. 1,784,189, for a propellent powder and method of colloiding same. This invention contemplates using a nitro-aromatic or nitroaromatics in the powder composition and employing only sufficient solvent to carry them completely into solution.

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Book Reviews

Springfield Muzzle-Loading Shoulder Arms. By Claud E. Fuller. New York: Francis Bannerman Sons. 1930. $4.50.

THIS well-indexed and attractively printed volume is replete with material of deep interest to students of the history of American military small arms. Since the publication by Sawyer of the first and third volumes of his "Firearms in American History" series, no comprehensive addition to the literature on our military shoulder weapons of bygone days has appeared. The present work fills many a broad gap, and answers numerous questions that have long perplexed the minds of collectors and historians.

The data offered is voluminous. It includes very complete descriptions and illustrations of flint and percussion-lock muskets, muskatoons, rifles, carbines, and pistols, as produced by our Government armories and individual subcontractors from 1795 to 1865, not to speak of the French Charleville musket, Model 1763, after which our original Springfield (Model of 1795) was patterned. Unfortunately a large amount of adventitious material is included, which one must wade through in order to get the gist of the subject matter. This could have been digested and offered in concentrated form as the body of the work, the numerous and often lengthy documents which abound in the text being relegated to appendices. In this manner, all of the essential information, now spread helter-skelter through the book, could be presented in the first fifty pages, at a saving to the reader of much time and effort.

In spite of this drawback, however, the volume, containing as it does material which could be duplicated elsewhere only after years of patient research, remains an invaluable addition to the library of the arms collector and ordnance expert on whose shelves it should speedily find a place.

Virginia Iron Manufacture in the Slave Era. By Kathleen Bruce, New York: The Century Company, 1931. $4.50.

DR. BRUCE, Professor of History at the College of William and Mary and author of "Economic Factors in the Manufacture of Confederate Ordnance" (ARMY ORDNANCE, Vol. VI, Nos. 33 and 34) will be remembered by readers of this Journal for her scholarly contributions to these pages. Few historians have the research faculty and ability of Dr. Bruce particularly in the much neglected economic field of the iron industry of the American South during the late 18th and the early and middle 19th centuries.

A new light is shed on Virginia history by this interesting study—a publication of the American Historical Association—of a little known phase of Southern life. It has been the general belief that Southern genius prior to 1860 was confined to politics and agriculture and that the Negro slave was not an industrial asset. Dr. Bruce's book shows conclusively that this belief is not founded on fact; that Virginia had a thriving industry, dependent largely upon slave labor, which grew to such importance that it vitally affected the course of the Civil War.

The book first traces the origin and growth of the iron industry in Virginia, which had its inception at Jamestown in 1607 where the iron from the Virginia colony was first manufactured. It shows the contribution made by the in-

dustry to the Revolutionary War, and follows the industry's history through its decline to its revival in Richmond, when plentiful coal and adequate waterways helped measureably in bringing it to its peak of development in 1860. The final part of the book shows the industry as the mainstay and the laboratory of the Confederacy.

Dr. Bruce's study is written with superb literary skill and presents its subject in a most interesting manner, casting side-lights on the social and economic conditions in Virginia during the early periods of its history. Her present book is based largely upon manuscripts of the Tredegar Iron Works, the chief munitions factory of the Confederacy, which are not accessible to the public.

Acoustics—A Text on Theory and Application. By G. W. Stewart and R. B. Lindsay. New York: D. Van Nostrand Co., Inc. 1930. $5.00.

THE theory of acoustics has great beauty. So say these writers and their ability to develop this beauty is vouchsaved by their long familiarity with the subject. General acoustic phenomena are treated in the classical manner in the early chapters of the book following which the authors unfold the newer acoustic impedance theory. Specific problems such as those relating to horns and acoustic filters are developed by this theory as well as the means for measurement of acoustic impedance.

In the later chapters the discussion of many practical acoustic devices of vast present-day importance, such as loudspeakers and microphones, is tucked away somewhat briefly as compared with a subject of less general interest, subaqueous sound ranging, which is covered in a most comprehensive manner. The practical applications of newly discovered data on architectural acoustics should appeal to engineers charged with providing rooms or auditoriums having definite acoustic requirements. To those engaged in the rapidly expanding science of acoustics this valuable reference is recommended.

With Meade at Gettysburg. By George Gordon Meade. Philadelphia: War Library and Museum of the Military Order of the Loyal Legion of the United States, 1930.

THE grandson of Major General Meade has compiled this interesting narrative account of the campaign and battle of Gettysburg from "The Life and Letters of George Gordon Meade," which he and his father produced. It is concerned with the Gettysburg campaign from the time when General Meade was given command of the Army of the Potomac on June 28, 1863, until the retreat of the Army of Northern Virginia across the Rappahannock River in July of the same year. The letters quoted are intimate personal ones exchanged by General Meade with close friends and high officials and contain information on contemporaneous occurrences and thought which provide a background of intense interest for this important phase of the Civil War. A man's character is revealed in no better way than by his personal correspondence and that of General Meade shows him to be a strong, fearless and conscientious soldier.

The military situation leading up to the Gettysburg campaign is briefly reviewed and the day by day activities of both armies described, together with the information each commander received from time to time on which to base his estimate of the situation and the probable intention of his opponent. The author has been very successful in presenting a highly entertaining and clear study of Gettysburg and the Union commander as well as many of his subordinates. The illustrations and maps are excellent and of material assistance in following the narrative. This book should be a help to every student of military history and operations.

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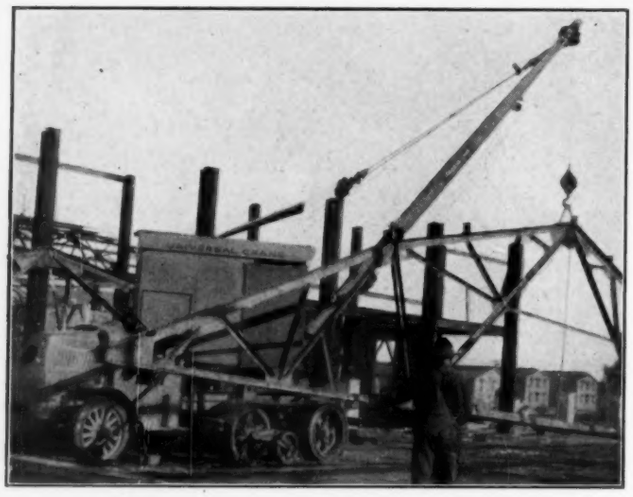

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Supplement to the Handbook of War Ships. 26th Edition. By B. Weyer. Munich: J. F. Lehmann. 1930. 2.50 Marks.

The German War Fleet, 1914-1918, and Its Disposition. 3rd Edition. Munich: J. F. Lehmann. 1930. 1.80 Marks.

IN presenting these booklets the publishers announce that as a result of the general economic depression, it was not possible to publish the complete 1931 edition of the Handbook of War Ships, as originally planned. Instead these current revisions are issued as a supplement to the preceding edition. It contains, briefly, additions to the list of ships, new firms, and naval construction designs. Thirty-seven illustrations of new ships are included. Especially valuable is the review of the London Naval Disarmament Conference, the most important accomplishments of which are stated. A study of this review discloses that the London Conference effected only in a limited degree the actual disarmament of the three foremost naval powers.

The volume on the German Fleet of the World War is also gotten out in a new edition. This volume contains a list of all ships in the German navy at the time of the outbreak of the war, and all ships built during the war (including U-boats and airplanes), and indicates their disposition. Valuable information is contained in the newly published illustrations of several of the last types of ships of the Imperial Navy.

Human Nature and Management, The Applications of Psychology to Executive Leadership. By Ordway Tead. New York: McGraw-Hill Book Company. 1931. $3.50.

IN what way and to what extent can a knowledge of human nature be helpful in solving the problems of management? If any skeptics examine this book, they will find convincing evidence of the utility to an executive of a psychological background in dealing with human beings. Wherever human activity is definitely organized and regulated, in business, in the factory, or in the Army, there is a fertile field for the practical use of psychology.

The psychological problems studied in this book cannot be analyzed with the precision and finality of geometrical theorems. Nevertheless, the basic psychological principles are exceedingly helpful in suggesting ways and means of directing and controlling intellectual and emotional forces to the end that an efficient human machine can be created in place of the mediocrity too often caused by ignorance of human nature. The book is intensely practical and will prove useful not only in pointing out ways to solve management problems but also in helping the reader to improve his own mental processes.

A Chateau at the Front, 1914-1918. By the Marquise de Foucault. Translated by George B. Ives, Boston: Houghton Mifflin Company. 1931. $4.00.

CASTLES in Picardy from 1914 to 1918 lacked much of the charm usually associated with life in a French chateau. In spite of the war, except for short periods, the Marquise de Foucault stayed in her chateau of Pronleroy located in the zone of the armies during all that time. She kept a record of her experiences in a diary which is now published under the above title.

For twenty days in 1914, the invaders were between her and Paris. After their retreat to the north, successive groups of officers of the infantry, cavalry, artillery, engineers, colonials and the general staff were billeted in the chateau. The observations of the chatelaine concerning the events of these four exciting years describe a most interesting and novel aspect of the war and are far more pleasant reading than the majority of narratives that have recently appeared.

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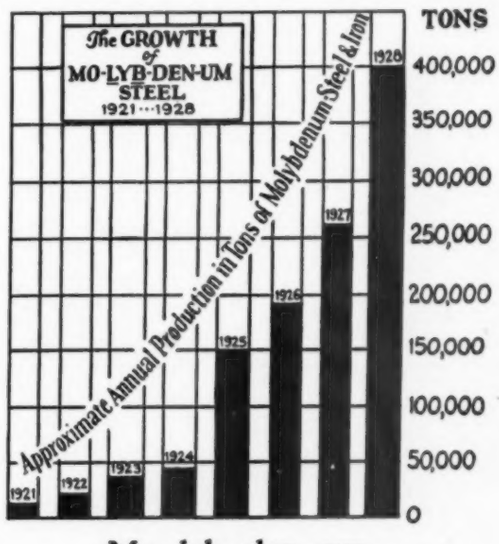

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Gives the utmost in speed, economy of operation, convenience and dependability. Many features include: six-cylinder Diesel engine; steering from cab; standard or extra long and wide mountings for soft ground; swing, hoist and propel at one time.

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***42-B big output 1 ½-yard steam shovel**

Readily convertible for clamshell, dragline and crane work, this new steamer gives you many up-to-date improvements as: steering from cab; simple, accurate control; low center of gravity; less vibration; large capacity boiler.

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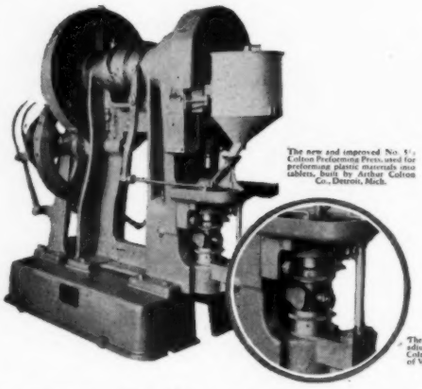

The new and improved No. [illegible] Colton Preforming Press, used for preforming plastic materials into tablets, built by Arthur Colton Co., Detroit, Mich.

Threaded plunger and threaded adjustable nut assembly on the Colton Preforming Press, made of Vanadium Steel.

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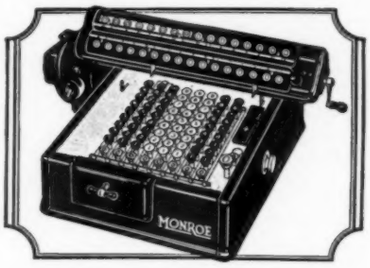

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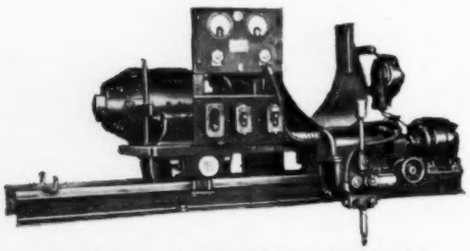

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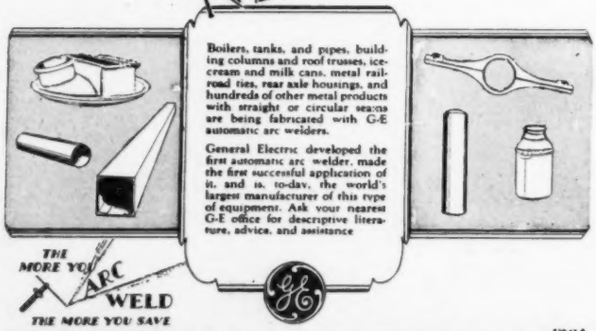

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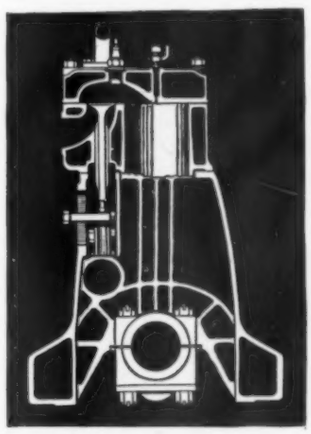

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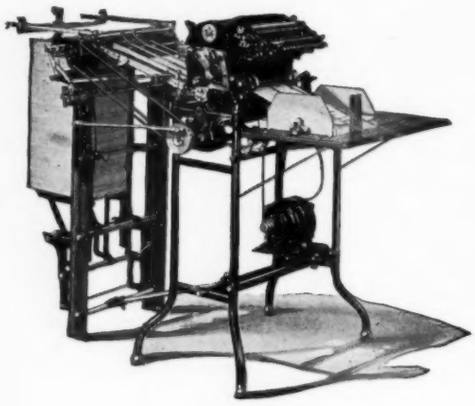

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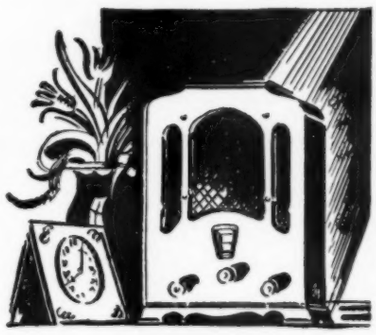

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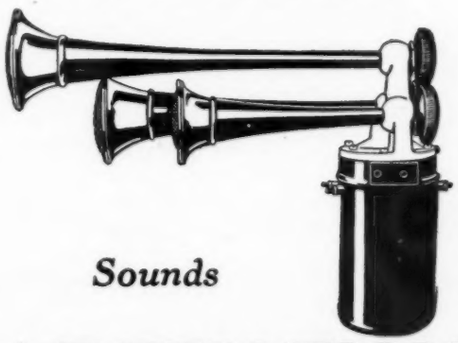

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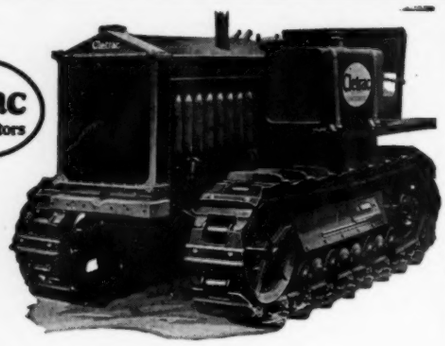

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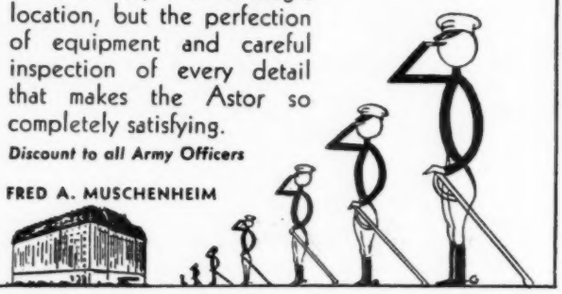

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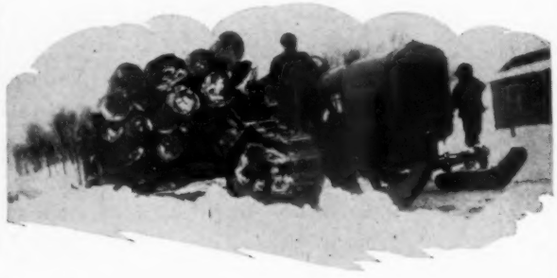
There's Power in WARCO Rear Crawlers



Whether hauling cannons, wagon trains, or loads of logs in the north woods, WARCO rear-type crawlers give traction to the tractor enabling it to pull where wheels would be helpless.

Advantages of rear crawlers are easier steering, and faster travel without sacrifice of pulling power or bearing area.

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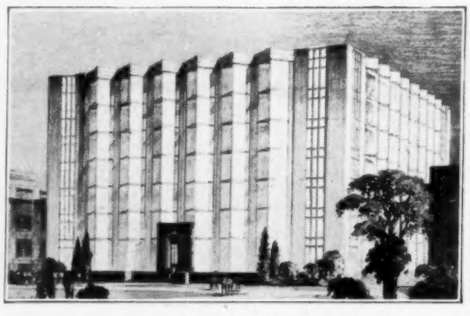
Manganese and Carbon Steel Castings

THE SMITH

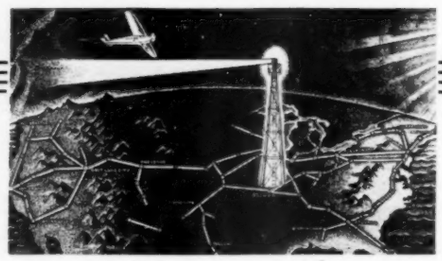


ARCHITECTS: HOLABIRD AND ROOT CHICAGO

RESEARCH AND ENGINEERING BUILDING

● Here, under the most ideal working conditions, engineers and scientists to the number of one thousand will explore further into fields of industrial research and development. This force will be built up from the present group of five hundred engineers who have already made such outstanding contributions to industry in the development of new and better ways of manufacturing and in the mechanization of mass production.

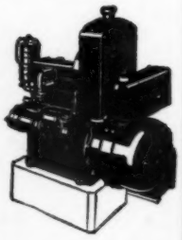
A·O·SMITH CORPORATION
GENERAL OFFICES: MILWAUKEE, WISCONSIN



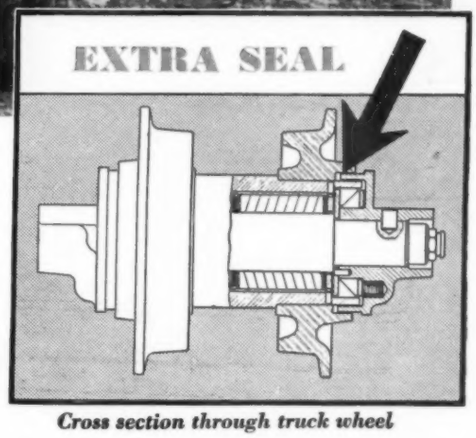
Helping The Aviators ALL NIGHT LONG

Through the night sweeps a powerful beam of light signaling safety to navigators of the air. Confident eyes watch for this light from the cockpits of mail and passenger planes and set their courses. Powerful Kohler electric plants operate hundreds of these beacons for the U. S. and foreign governments.

Kohler plants come in models from 800-watt to 10 K. W., generating 110 volt electric current — without storage batteries. Write for catalog and complete details. Kohler Co., Kohler Wis. Manufacturers of Kohler Plumbing Fixtures.



KOHLER OF KOHLER



Cross section through truck wheel

Built for a Long, Hard Life

Skilled Engineering combined with correct materials makes it possible for Allis-Chalmers tractors to live long and serve well under conditions like that illustrated. The *dirt-sealed* truck wheel construction is one of many features built into these tractors to combat mud, sand, dust and other severe operating conditions.

A free trial *on your job* ***Ask your Dealer***

Monarch "75," "50" and "35" track-type tractors. Model "U" wheel and track-type tractors and power units

ALLIS • CHALMERS • TRACTORS

SPRINGFIELD, ILLINOIS . . . MILWAUKEE, WISCONSIN

A FAST SPRINTER covers a distance of 40 yards in 4.09 seconds when running at 20 miles per hour.

A PLEASURE CAR covers 40 yards in 2.05 seconds when traveling at 40 miles per hour.

A DUCK covers 40 yards in 1.363 seconds when traveling at 60 miles per hour.

AN AEROPLANE covers 40 yards in 0.682 seconds when cruising at the rate of 120 miles per hour.

A CHARGE OF BIRDSHOT travels over 40 yards in 0.144 seconds or at the rate of 568 miles per hour.

TIME *and* DESTINATION

WHILE the above drawings show an interesting comparison in speed, they also form a striking example of the limitations imposed by time. The sprinter is not always in form to run his best, nor is it necessary that he equal his best record, as he races against a competitor. The duck does not always fly at the rate shown above, but changes its speed depending upon the danger to which it is exposed. The automobile is capable of far greater speed than that regulated by traffic laws, but the driver must exercise control to obey traffic signals. The aeroplane may attempt to maintain a constant cruising speed but this speed is necessarily varied when it climbs over mountains or descends to a landing field. The shotgun shooter, however, wants his box of shells to be uniform so that each shot load will travel to its target at the same invariable speed.

The automobile driver does not attempt to reach his destination by traveling at a fixed speed. He would have no use for an engine which was not provided with a throttle that would enable him to slow down in traffic and speed up on the open road. He may vary the speed at which he is traveling by as much as 50 per cent and still be sure of arriving at his destination. On the other hand, a charge of shot travels so fast that the shooter is unable to see it in the air, consequently he has to depend blindly upon his experience and the uniformity of the ammunition when leading a flying target. He is not at all interested, therefore, in actual time intervals or the rate of speed of his ammunition. A mathematical analysis will show why the shooter is so dependent upon uniformity.

Assume the target to be a duck cross-flying at 60 miles per hour, 40 yards distant from the shooter. As it takes 0.144 seconds for the shot charge to travel 40 yards, the duck will travel a distance of 12.68 feet in this same time. Therefore, a shooter must aim approximately 12 feet ahead of the duck when he pulls the trigger in order that the shot charge will meet the target. If his shotgun ammunition varies by even a small percentage he would miss the target entirely—shooting behind it with a low velocity cartridge and ahead of it with a high velocity cartridge.

This readily illustrates the need for very accurate control in powder manufacture, in order that the shooter will have at his command an instrument of great precision on which he can depend and benefit by his experience.

The du Pont Company with its experience of 129 years and its present resources can supply to ammunition companies the type and quality of powders required to maintain the reputation of ammunition manufacturers and the confidence of the shooters.

E. I. DU PONT DE NEMOURS & COMPANY, Inc.

Smokeless Powder Department, Wilmington, Delaware

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Smokeless Shotgun Powders

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For information on Target-Shooting, write to National Rifle Association, Barr Bldg., Washington, D. C.; on Trapshooting, to Amateur Trapshooting Association, Vandalia, Ohio; and on Skeet, to National Skeet Association, 108 Massachusetts Avenue, Boston, Mass.